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Conducted by MAJOR B. BADEN-POWELL, F.R.A.S., F.R.Met.Soc., and E. S. GREW, M.A.

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Physical Interpretation of the Canals of Mars.

WRITING in the *Astrophysical Journal* for July, 1907, Professor Newcomb discusses at length the optical and psychological principles involved in the interpretation of the so-called canals of Mars. The features of the planet as described by Schiaparelli, Lowell, and other observers are so remarkable that the question of their interpretation is of great interest, especially as the divergence between the descriptions and delineations of these features emanating from different observers is well known, and seems scarcely normal. Accepting, as we should, the general principle that what is seen by a single practised observer under the most favourable conditions affords evidence which completely outweighs that of less favoured observers, we have still to admit that absolute inconsistency between the two should not be found. The details successively added under improving conditions may not be inconsistent with a rational interpretation of what was previously seen. It has been emphasised by Williams and also by Lowell that an observer with the widest experience, in seeing only one class of features may fail in seeing those of another class.

The optical and psychological principles involved in the interpretation have been investigated by Lowell, but in the present paper Professor Newcomb goes further and seeks to define more exactly the causes on which depend the judgment of an observer in scrutinising faint and difficult features on the surface of a planet. Two sets of principles are directly concerned, one optical, the other psychological. Under the first head are included all the causes which affect the formation of an image on the retina of the eye; under the second the causes which affect the observer's perception of that image.

A.—Optical.—The principal agencies which come into play in the first class are the atmosphere, the instrument, and the eye. Dealing chiefly with the performance of the instrument, it is noted that very little appears to have been published where the effects of the secondary aberration of an achromatic lens, and the primary aberration of the eye, are stated in a form easily applicable to the present question, and Newcomb therefore proceeds to summarise the data and formulæ in such a way that they may be readily applied, the final equation giving the angular radius of the circle of aberration as projected on the focal plane of the objective. As a definite example the 36″ objective of the Lick telescope is taken and the various constants computed, taking the points of the spectrum corresponding to C, D, 5614, E, and F for comparison. It is shown that the aberration circle is contracted by diminishing the aperture, but a limit to this is soon reached on account of the rapid increase of diffraction phenomena with small apertures. The best ratio for aperture to focal length for balancing the effects is given as 1.20, which gives the result that by no focal setting can all the light contained between C and D, or between wave-lengths 5894 and 5614, a range of 280 tenth-metres, be brought within an aberration circle the radius of which is much less than 0″.10. If there is a possibility of the image being made materially smaller, we may regard it as certain that the effect of atmospheric softening and of diffraction will be to enlarge the image beyond this radius. If we set the focus so as to secure a brighter central point, we increase the radius for the rays on each side, and *vice versa*. The range of wave-lengths between the lines C and E is 1290, and extends from the dark red to the fainter portion of the green, excluding the blue entirely. Were all the light outside these limits brought in and distributed so as to form a uniform spectrum, it is calculated that it would be as bright as if the light of the brighter portion were spread between the limits C and E, and therefore *in using the best refracting telescope under the best conditions we cannot expect to bring more than one-fourth the light within a circle of radius* 0″.10, *three-fourths being distributed without this circle.*

The injurious effect of this dispersed light may be lessened by the use of a suitable absorbing screen, which is among the devices used at the Lowell Observatory, but it seems quite certain that it could not be so applied to bring the bright central image within the limit of 0″.10.

We have next to consider the respective effects of this aberration upon a star and upon a line. In the former case the light of each ray being spread into a circle of radius equal to the aberration, the surface brilliancy of the disc produced by the light of any ray is inversely proportional to this aberration. It therefore rapidly diminishes as we go out from the central point, which accounts for the fact of a companion star being visible at a distance of less than 0″.1 from the central star.

Figures are given to show that when a line is observed the result is materially different. If the line is bright its width will be apparently increased, the illumination at any point outside the line being greater than if the light were only dispersed from each point instead of the actual aberration circle. In the case of a perfectly dark strip on a bright background the darkening would be distributed over a belt several times wider than that of the actual dark strip, no definite limit being assignable, since it would fade off indefinitely in each direction. All that we can say with precision is that the total amount of darkening or abstraction of light would be equivalent to that produced

by the central black band, and no practical gain would accrue by aiming at more algebraic precision in the expression of the illumination in detail.

B.—Psychological.—Notwithstanding the volume of investigation on the psychological principles of vision, that branch of the subject which relates to accuracy of conception and estimate is an almost virgin field. Two distinct processes are involved in vision. One is the conscious stimulus of the optical nerves by light, the other the perception by the mind of a real or supposed object indicated by such stimulus. The most remarkable property of vision is that it does not consist merely in taking account of the sensation, but is occupied almost entirely with the perceptive act, in which the sensation is dropped out of consciousness. *Visual inference* will be a good term to describe the act by which the mind unconsciously draws conclusions as to an observed object from the image formed by its light on the retina. A fundamental property of this form of inference is that it comprises not only *seeing*, in the ordinary sense, but a rational interpretation or conclusion based on previous experience of what is seen. Thus, suppose oneself looking at a white line on a black background. We know from our experience in looking at a gas lamp at night, or a bright star, that the light emanating from a bright point is spread over a surface of several minutes radius, which commonly increases with the age of the individual. It follows, then, that when we look at a white line, the image formed on the retina, even in the best eyes, must be 2′ or 3′ in breadth, howsoever thin the actual line may be. But, as a matter of fact, experience leads us to *perceive* only what we should call a line, though we know rationally that it must have a sensible thickness.

In this process we have a possible fruitful source of error of vision which, instead of being corrected by experience, tends to be strengthened by it. A mind accustomed to dealing with objects the correct perception of which depends mainly on visual inference, is naturally prone to extend that inference to cases where the conclusion would be illusory. Having this in mind, we see that observers trained in different ways may depict the same object very differently. The process in question naturally plays a more important part as the object observed approaches the limit of visibility. The fantastic character of the forms which may be seen in the coals of a fire by one sitting before it is well known, but this example is not pertinent to the present theme, and is mentioned only as an additional illustration of this form of inference.

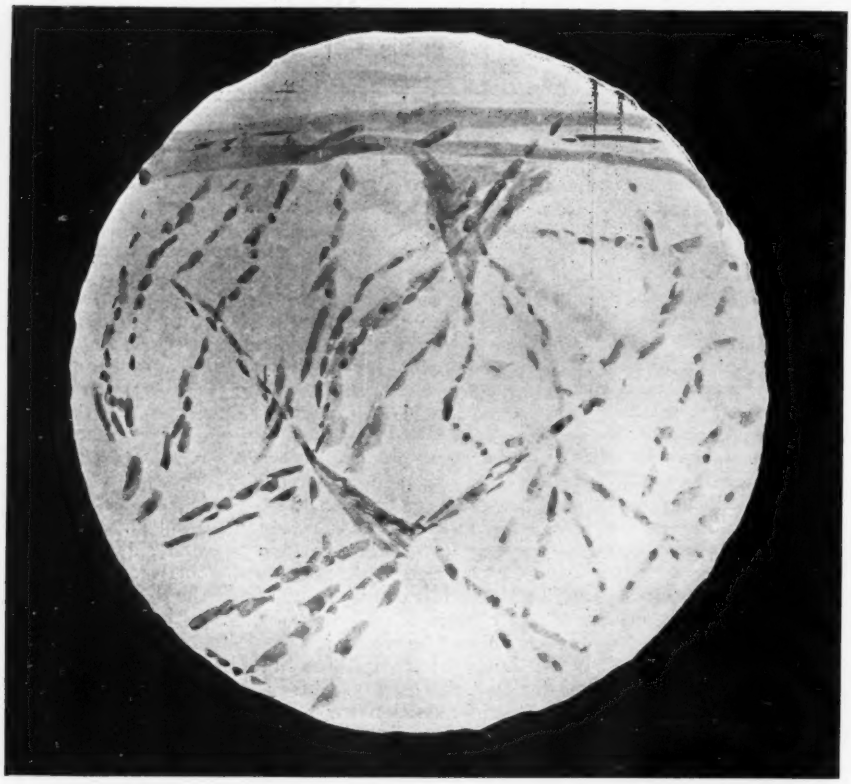


Fig. 1.—Wash Drawing by Prof. Simon Newcomb. Reduced from a diameter of 38 cm.

A number of experiments have been made on the visibility and visual interpretation of dark lines on a white background. They differ from the similar ones made by Lowell in that, instead of taking the sky as a background and a distant hill as the dark line, Professor Newcomb has used lines drawn with ink on paper, the latter being placed in a window and observed by transmitted light. This system was adopted because the conditions in this way approach more nearly to those of actual observation on the disc of a planet, when the apparent background is not formed by the uniform blue light of the sky, but by a more or less mottled surface, and the lines are affected by atmospheric dispersion and telescopic aberration. Another point of difference was that instead of making degrees of visibility the main object, Professor Newcomb sought to investigate the nature and limits of visual inference. The ruled lines were about 0.7 mm. in thickness, the length of all being about 30 cm. One was continuous, others were broken at regular intervals by spaces 1 cm. in length. At a distance of 10 metres all the lines looked continuous and uniform. As the distance was diminished the perception of the gaps did not come on suddenly, but by gradual steps, the first impression being that the lines were affected by irregularities in the form of thicker portions or blotches. It thus follows that discontinuous portions of a line may be integrated into a continuous line. If this were all, any error of judgment might be corrected by proper means, but a further effect was observed, in that in one case what was faintly judged to be a continuous line up and down the paper was really a short line with a faint shade be-

low it, which by visual inference was merged into the line, and led to the acceptance of its continuity across the paper. A greater surprise was felt when a paper known to have no visible lines on it was placed in the window, and it was fancied that a system of continuous lines were present. On closely examining the paper these were found to be due to an irregular shading of the tissue of the paper as seen by the transmitted light, the minutely darker ill-defined regions which were scattered all over the paper being integrated into lines like those previously under observation. It is suggested that there is here a very interesting field in which the best astronomical observers might well experiment with each other by placing in a window a number of such papers, some with barely visible lines and some without, and determining the degree of certainty with which the two could be differentiated at various distances.

Professor Newcomb presents the result of an experiment of this kind. A circular disc was prepared with light shadings, bearing a faint resemblance to what might be supposed to exist on Mars, but which did not contain any canal system of the kind commonly seen. This disc is reproduced on a reduced scale with sufficient precision in Fig. 1. Its breadth and distance were arranged so as to correspond to the apparent disc of Mars under the usual magnifying power. The markings were then drawn by Professors W. H. Pickering and S. I. Bailey, of the Harvard College Observatory, with the results shown in Fig. 2. Neither was made acquainted with the actual nature of the figures until after the sketches were made. It seems unnecessary to make any detailed comparisons between the original and the drawings, beyond remarking that they seem to be affected by practice. Professor Pickering was an experienced observer of the canals of Mars, while Professor Bailey, though occasionally looking at Mars, had not made so long a study of the planet.

Additional sketches of the wash drawing were also made by Professor E. E. Barnard and Mr. Philip Fox, of the Yerkes Observatory, from a distance of 96 feet. Their drawings are reproduced in Figs. 3 and 4.

C.—Possible Interpretation of the Canals of Mars.—The next step is to apply the preceding results to the interpretation of the marking on Mars, specially of the canal system. We must carefully guard against the error of considering this whole system as something which must stand or fall as a unit. Some of the markings are seen in substantially the same position by so many observers that no question can be raised as to their subjective reality. In fact, several of them have been photographed. This does not prevent our saying that the objective reality of the system of some 400 canals catalogued by Lowell may be very different from their subjective appearance.

It will be sufficient to base the following discussion solely on the work of the Lowell Observatory not only on account of the excellence of the instrument and the perfection of the atmospheric conditions, but from their unequalled continuity, the care with which the minutest details were looked for, and the general critical character of their entire discussion. First of all, at the dis-

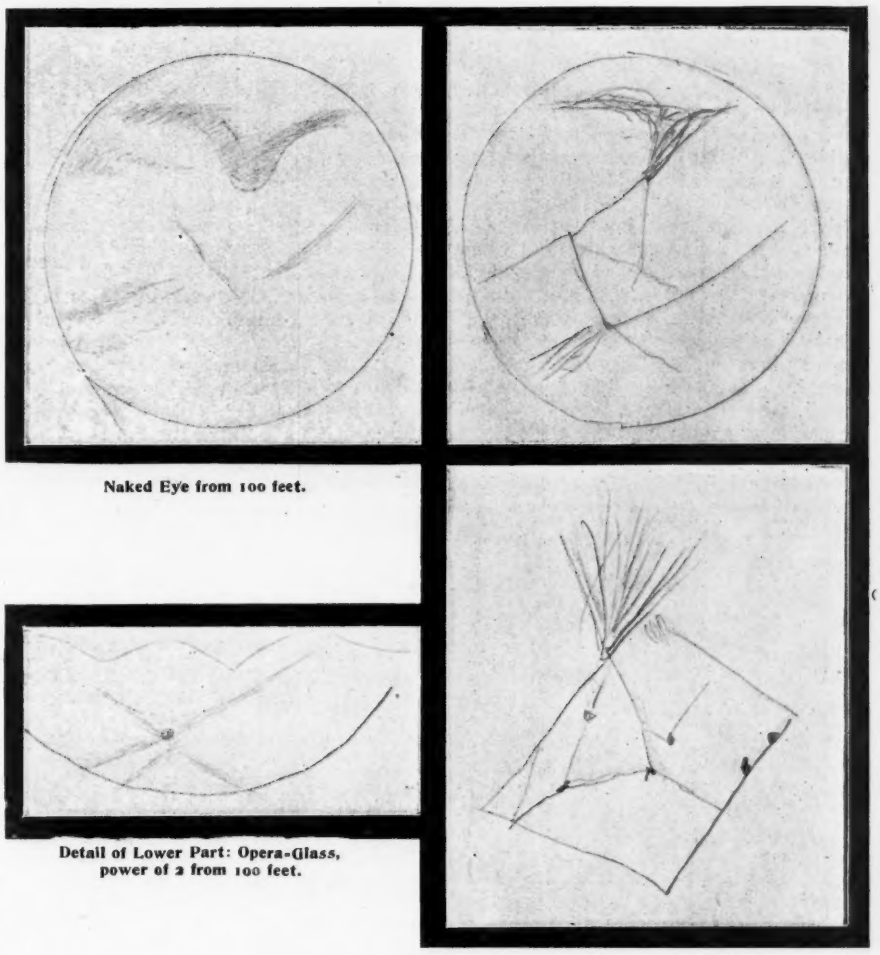
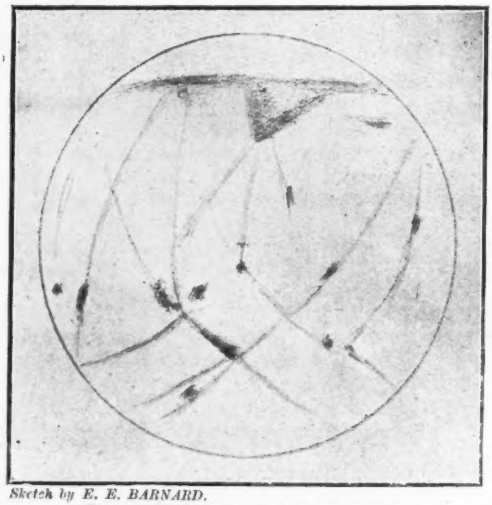

SKETCHES
By S. I. BAILEY.
By W. H. PICKERING.
Naked Eye from 100 feet.
Detail of Lower Part: Opera-Glass, power of 2 from 100 feet.
The Upper Sketch with Naked Eye from 30 metres.
The Lower, Detail with Opera-Glass from 100 feet.

Fig. 2.

tance of Mars at various oppositions, one second of arc will commonly be subtended by a linear distance on the face of the planet varying from 200-300 miles (320-480 km.). If the opposition occurred absolutely at perihelion, the equivalent might be as small as 175 miles (282 km.). The figure 200 miles (320 km.) may be taken as normal for the ordinary case. Conceiving now an absolutely black line on Mars, of indefinite length, and of a breadth of 3-4 miles (5-6 km.). The angular geometric width of the strip may be o″.01 to o″.02, and from the previous discussion it will be seen that the image of this cannot be black in the best refracting telescope, being spread out into a band of which the darkest part will be o″.2 broad, bordered by a yet wider shade. In linear measure on the planet this would be 40 miles or upward in breadth. Now Lowell found a wire projected on the sky vanished with increasing distance only when its breadth subtended a diameter less than o″.69. By what is probably an established fact of photometry, upon an illuminated surface of the best brightness, a change of 1 per cent. of the light is discernible. But the width of o″.69 is only visible when seen perfectly black against a uniform background. Conceding, then, that a perfectly black marking on Mars 3 miles (5 km.) broad might be visible on a uniform surface, on the actual mottled surface the minimum *black* width discernible would be 8-10 miles (13-16 km.). As the canals cannot be absolutely black, we must about double the above, and we may say that the actual width of the narrowest visible canals on Mars must exceed 10 miles (16 km.), and may be as great as 20 miles. Adding the border of 20 miles on each side necessarily produced by aberration, diffraction and softening, the apparent breadth in the telescope and on the retina would be 50 miles (80 km.), and upward. This result differs widely from that of Lowell, who estimates 2 or 3 miles as the breadth of the narrower canals, and the cause of the difference is as stated above.

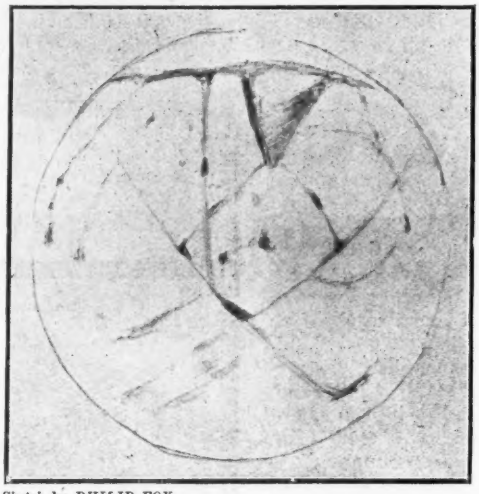
Considering now the entire system of 398 canals.



Sketch by E. E. BARNARD.
Fig. 3.—With Naked Eye from 96 feet.

About 2,000 miles is the common length, many exceeding 2,500 miles. Assuming 400 canals of a mean length of 1,500 miles, the area which the entire system will subtend on the retina of the terrestrial eye with the aid of the best refracting telescope. The area of a mean canal in square miles will be 1,500 by breadth, and the total area 400 by 1,500 by breadth. Then taking in succession (1) a mean actual breadth on the planet of 7 miles as assigned by Lowell; (2) a mean of 15 miles, as modified by Newcomb; (3) an enlargement of 40 miles by aberration, we have :—

(1) Canals black; objective area, 4,200,000 sq. miles.
(2) Canals half tone; objective area 9,000,000 ,,
(3) Canals enlarged; subjective area 33,000,000 ,,



Sketch by PHILIP FOX.
Fig 4 —With Naked Eye from 96 feet.

The actual surface of Mars is about 55,000,000 sq. miles. Thus the total area of the 400 canals can scarcely fall much below one-half the total area of the planet, and may be greater. So complex a network within a disc only 20″ in diameter could not but be interpreted largely according to the experience and habits of the observer. Although in this discussion the writer has not questioned the subjective reality of the canal system, he cannot but feel that the proof of its objective reality is incomplete until the observers of the system investigate the processes of visual inference in their own eyes. For the illustrations reproduced, we are indebted to the *Astrophysical Journal*. C. P. B.

The Association of Economic Biologists.

The fifth general meeting was held in the Imperial Institute on Thursday, July 4. The President, Mr. A. E. Shipley, M.A., F.R.S., occupied the chair.

After the formal business the following papers were read : By Mr. Cecil Warburton, Some Notes on Ticks. The author dealt with the classification, means of distribution, and discussed the leading generic characters. Mr. E. R. Burdon detailed the results of his experiments with the spruce-gall and larch-blight disease. His results showed that a paraffin emulsion applied early in the year, before the buds open and whilst the insects are still hybernating, was most effective. Mr. Walter E. Collinge gave an account of his work on the cecidomyidae or gall midges, and appealed to entomologists and others for assistance in working out the life-histories, etc., of this very difficult family of Diptera. An abstract of a paper by Professor A. D. Imms, on a Disease of Bees in the Isle of Wight was read. Mr. E. S. Salmon read a short paper on the American Gooseberry Mildew and the proposed legislation, and Mr. C. Gordon Hewitt discussed the binomics of the calypterate muscudae, and their economic significance. A demonstration was given by Mr. W. G. Freeman, the Superintendent of the Colonial Collections, in the Public Galleries of the Institute, and visits were also paid to the Research Laboratories. The next meeting will be held at Edinburgh about Easter, 1908.

Dew Ponds.

Supplementary Remarks.

By EDWARD A. MARTIN, F.G.S.

LOOKED at from an economic point of view, there is every reason why the subject of the making of these ponds should be thoroughly gone into, and experiments undertaken to ascertain how best to induce the precipitation of aqueous vapour on the hill-tops; firstly, because there are in such places no running streams as in the valleys, whilst the demand for a water-supply is very great for the watering of cattle; and, secondly, as a reserve supply, when, as has frequently been the case, the ponds and streams in the vales have failed.

That great interest is felt in the matter I am convinced, by the number of communications which have reached me.

Professor Henslow has called attention to the experiments which Dr. Marloth conducted at the top of Table Mountain, which resulted in showing a remarkable amount of precipitation induced by surrounding a rain-gauge of 5 inches diameter with reeds a foot high. This gauge collected 16 times the quantity of water contained in an open gauge, between December 21, 1902, and February 15, 1903. One can scarcely credit this remarkable result, although there is no reason to doubt its accuracy. Professor Henslow has kindly furnished me with a copy of Dr. Marloth's paper, in which he recorded his observations, and besides attributing to this abundance of moisture the luxuriance of the vegetation of the mountain, he speaks of it as the reason "why there are little lakes, even late in summer, on the top of Table Mountain, as well as close to the summit of Du Toit's Peak." This is additional evidence of the important part played by low vegetation around a pond in arresting and condensing aqueous vapour. It is desirable that the mists brought on to the South and North Downs by the south-west winds may be encouraged to deposit their vapour by surrounding ponds with shrubs and bushes.

I have sometimes almost wondered how it is that so many fields of wheat and barley are able to survive the long spells of drought which they experience, especially when they are growing upon a dry, chalky, flinty soil. On one such occasion, when in the Isle of Thanet, it was noticeable, in the early morning, that each stalk of corn was quite moist, and was acting as a conducting rod for vapour which had condensed upon it. In this way the roots were watered in the absence of rain. This bears out Dr. Marloth's experiments. Still, it must be admitted that some dew-ponds, clean and clear as crystal, have no vegetation at all around them or in them.

I have just visited the dew-ponds near to Chanctonbury Ring. They are quite bare of vegetation. The chief one, that to the south of it, and in a direct line between it and Cissbury, is of ancient origin, and although I ascertained that it had been cleaned, I could gain no information as to its having been made within the memory of man. The two others, however, were made jointly by Mr. Goring, the owner, and Mr. Floate, of the farm. These were thickly puddled with clay, which occurs in pockets on the chalk hereabouts, a certain amount of lime being mixed with the clay as a precaution against worms. About a barrel and a-half of water was poured in, and then it filled itself. These have not since failed, not even in the long, hot summer of 1893, when the ponds in the Weald were dried up.

There is no doubt that a great supply of water could be obtained from Chanctonbury Ring itself if proper collecting arrangements were made. Although a great portion of the clump of trees is enclosed, a portion of the vallum and the enclosed space is open to the public, and the trees are of considerable height. The whole area reeks with moisture, and both the atmosphere and the sodden soil give evidence of the water which might be rendered available for economic purposes. I understand the Ring is frequently hidden from view, when, as is said locally, "it has its cap on," *i.e.*, of mist.

In my previous article, I referred to Mr. H. P. Slade's "Treatise on Dew-Ponds" (1877), and briefly summed up the conclusions at which he arrived. That author now states that he has recently visited 15 dew-ponds in the neighbourhood of Lewes, only one of which was puddled, the remainder being concreted, cemented, or asphalted. "These all crack above the water-line, and, in a very short time after construction, begin to leak." In the pamphlet referred to, Mr. Slade showed the results of a large number of meteorological observations which he made, and these should be referred to now by anyone interested in the practical side of the question. I differ from him completely in so far as he attributes the filling of the pond to rain entirely, or almost so. I notice that he himself admits that from June to September at least, only one-half of the accumulated rainfall will go to replenish the pond. He dismisses in a few words the suggestion that dew or fog contribute anything to the supply, but this point of view requires greater consideration than he has given to it. I think it very certain that if the ponds of which he speaks had depended only on the very small supply of rain shown in the "examples" contained in the pamphlet, the pond would frequently have become as dry as those found on the lower ground. One must acknowledge, however, the skill and patience with which Mr. Slade pursued his observations. It is noticeable that during a 22 hours' observation, on July 21 and 22, the pond's temperature, 3 inches under the surface, varied between 67° and 87°, the former being found at 5 a.m., and the latter at 3 p.m. But 3 feet under the water the temperature only varied between 68½° and 70°, the former being between 4 a.m. and 5 a.m., and the latter being between 2 p.m. and midnight. It is noticeable that 5 a.m. was the only time when the surface temperature was lower than that 3 feet below the surface.

Thus the surface had a variation between 20°, but 3 feet below it had one of 1½° only, during the two days quoted. Somewhat similar results were found during each summer month, when one temperature per day only was taken. Thus, in June, the surface varied 17°, and 3 feet below it 10°; in July, the former varied 25°, the latter 9°; in August, 22° and 6°; and in September, 19° and 8°. In no case was the temperature at 3 feet found to be higher than that at the surface. From certain observations, taken at a depth of 1 foot below the surface, there appears to be a time, viz., between 4.45 a.m. and 6.45 a.m., when the temperature at this depth is slightly greater than that at the surface. This is when the surface has been chilled to its greatest extent by radiation, and I suggest that it is thus in the early morning that the greatest amount of precipitation of fog takes place, as it is undoubtedly the time when the greatest amount of fog, mist, or cloud, whichever one likes to call it, is seen rolling over the Downs.

XUM

Drought in Mauritius.

MAURITIUS is entering on the sixth month of a severe drought, which has seriously compromised the sugar crop.

In the North of the Island—the principal sugar growing district—the shortage of rain, and especially of rainy days, has almost equalled the disastrous drought, in the same district, of 1896-1897, which was the worst on record, and although certain estates in the highlands are anticipating normal returns for the coming crop, the total output is likely to be considerably reduced.

The growing season in the North may be considered to extend from October to the end of May. The vegetation during the remaining months being practically at a standstill, it naturally follows that a drought commencing in October or November and continuing until the following May is very serious.

In 1897, the reduction on some estates amounted to 60 per cent. of the mean crop; the rainfall during the previous growing season being as follows:—

Months.	Rainfall.	Number of Rainy Days.
October-November ..	48 % below normal	7 % below normal
December-January ..	39 % ,, ,,	37 % ,, ,,
February-March ..	57 % ,, ,,	30 % ,, ,,
April-May	72 % ,, ,,	15 % ,, ,,

The rainfall for the growing season, on which the coming crop depends, is as follows:—

Months.	Rainfall.	Number of Rainy Days.
November	64 % b low n rmal	9 % below normal
December-January ..	51 % ,, ,	3 % ,, ,,
February-March ..	34 % ,, ,,	13 % ,, ,,

From an agricultural point of view, taking into account the distribution as shown by the number of rainy days, the defect for the two droughts from October to April may be roughly estimated as

1897—60 per cent. below normal.

1907—35 per cent. below normal up to the end of March.

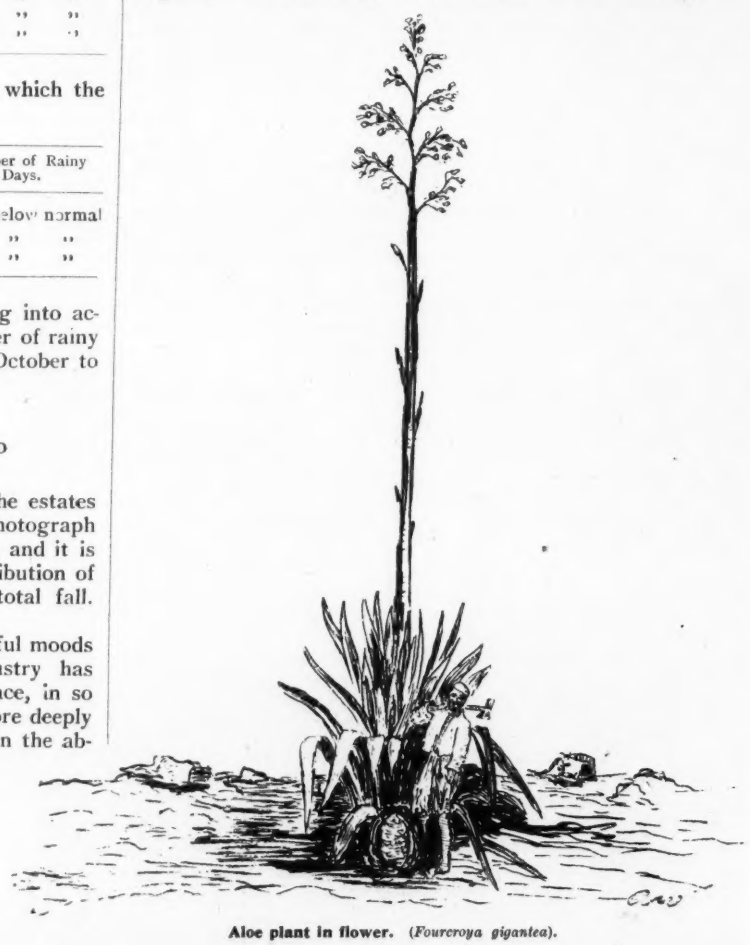
The type of land cultivated on some of the estates in the North is shown in the accompanying photograph (the cane is planted in between the boulders), and it is easily understood that on such land the distribution of rainfall is even more important than the total fall. (Photo I.).

The havoc which Nature in her most vengeful moods has wrought on the products of human industry has indirectly rendered immense service to the race, in so far as we have been led thereby to enquire more deeply into the relation between cause and effect. In the absence of bodily illness it is doubtful whether we should ever have become acquainted with the wonderful mechanism of the human frame. In much the same way it seems probable that few of the sciences would have progressed in the absence of either real or imaginary disasters. Astronomy owes its existence to astrology: astrology to the evil influences which the heavenly bodies were supposed to exercise over human destinies. Meteorology as a science is indebted, not to the "years of plenty," but to the "years of famine"—to the destructive force of the hurricane, the devastating flood, and the burning drought.

Although the present state of meteorology still offers excellent opportunities to the quack, the magnificent weather services of America, India, Australia, and Africa, the bewildering network of observing stations scattered over the whole of Europe, and which is being slowly extended over Asia to the extreme limits where Western civilisation has penetrated, provides data which, in the hands of the capable men who are at present engaged on their discussion, must inevitably lead to forecasts of the atmospheric tides as accurate at least as those drawn up for the ocean.

Notwithstanding that the exact relation which exists between the occurrence of droughts in different portions of the globe still remains hidden in obscurity, there seems little doubt that in 1896-97 Mauritius owed its shortage of rainfall to causes which intimately affected the rainfall of Australia, and produced the disastrous drought which began in 1895 and culminated in 1903.

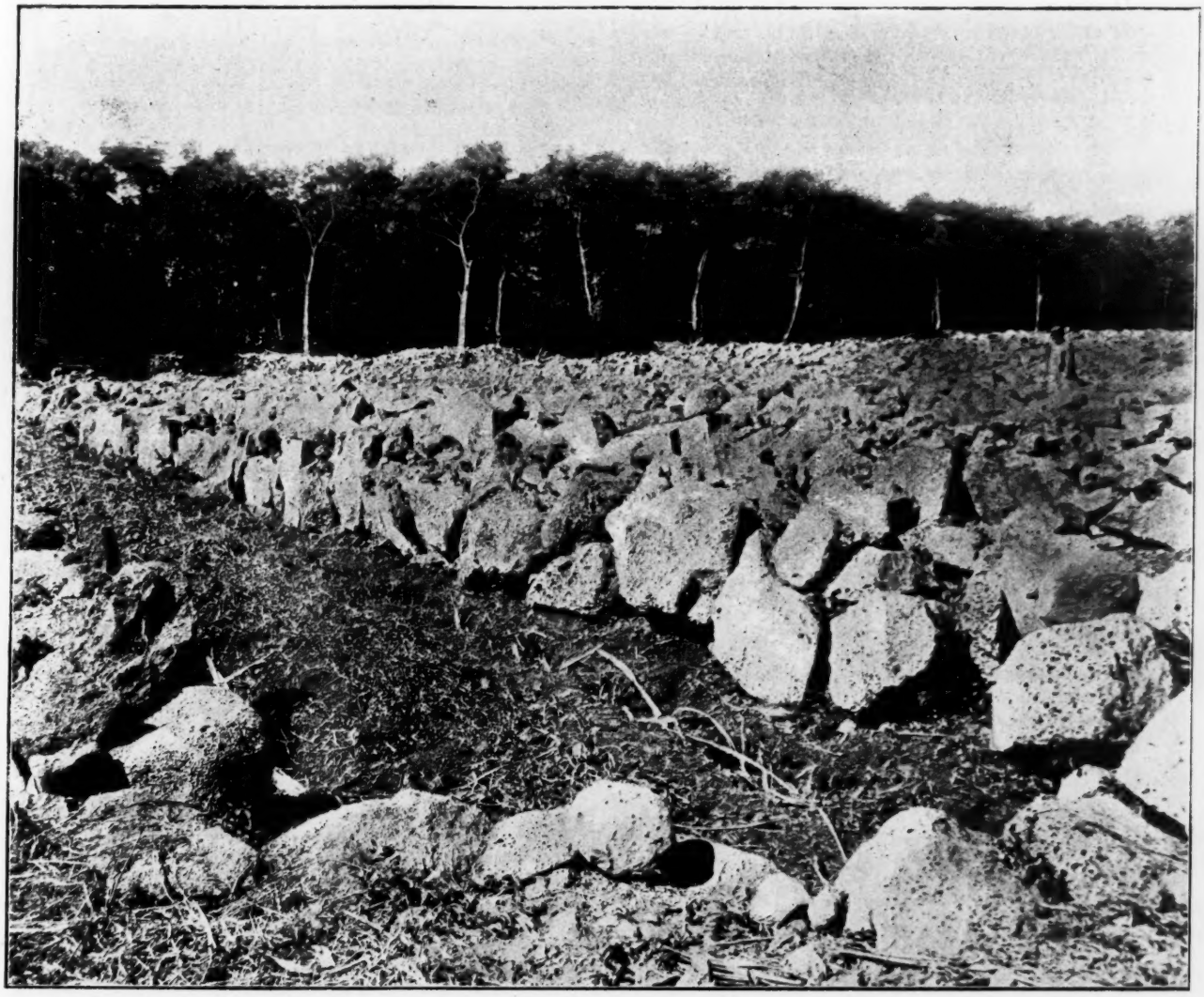
The controlling forces of Australian weather, as pointed out on several occasions by Australian meteorologists, are undoubtedly to be found in the moving



Aloe plant in flower. (*Fourcroya gigantea*).

anticyclones which traverse the South Indian ocean from West to East. Mauritius lies on the northern limit of this belt of anticyclones, and the alternations in the weather, the steady rise of barometer accompanied generally with cool southerly winds—which form such welcome interludes in the tropical heat—succeeded by a gradual backing of the wind to north-east, north, and north-west with falling barometer, then the calms with rain, thunder, and lightning of varying intensities, which ended practically in August. Is this a precursor of still another shortage for Australia?

The splendid work of the Lockyers, and others working on the same lines, has revealed unexpected relations between atmospheric conditions in various parts of the globe. Some of them may possibly only be coincidences, but there is not a shadow of doubt that each has made an advance toward the solution of the intricate problem of the interdependence of atmospheric changes.



A Sugar-Cane Field, near Pamplemousses, Mauritius

show unmistakably the alternation of anticyclone and V - shaped depression. The cyclone is only an occasional summer visitor.

The Director of the Royal Alfred Observatory, Mauritius, has recently shown in a paper presented to the South African Philosophical Society that droughts in South Africa are certain harbingers of misfortune for Mauritius, the interval between them varying from three to seven months. The present drought, beginning in November, succeeds a South African drought

Fortunately for Mauritius, the consequences of drought are not nearly so serious as in Australia and India. The Island raises practically nothing but sugar, importing almost every article of diet. The only conceivable cause of famine in Mauritius is war between England and another naval power, as the quantity of food-stuff could certainly not last more than a few months.

In comparing the statistics for Mauritius, we notice, as the principal effects of a bad crop, a considerable in-

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crease in the inmates of the prisons; the largest number on record occurring in 1898 after the 1897 drought; the least occurring in 1900, after a series of good years, including the largest crop on record between 1876 and 1900.

The marriageable young men were apparently at a premium in 1898, the least number of marriages on record since 1894 occurring this year. On the other hand, the registrar was kept busy in 1900 and 1904, the record showing an increase of 366 and 538 respectively on that of 1898.

If, however, our years of plenty empty our prisons and lay the foundations of domestic happiness, they bring in their train sorrow and suffering. The conditions which fill our storehouses with sweetness, fill our graves with the victims of malaria and carry the bitterness of death and separation into many a home. The death-rate, which in 1897 was only 27 per thousand, rose in 1903 to 40.

In this season of dryness, however, one plant, at least, presents an astonishing contrast to the sugar cane. The mountain sides are white with the blossoms of giant aloe stems, and the waste lands (*i.e.*, uncultivated lands) have been literally converted into forests. At the time of flowering, a shaft about the thickness of a man's arm shoots up from the heart of the plant, growing at the phenomenal rate of from 12 to 18 inches in the 24 hours, and, rising to a height of about 30 feet, bursts into a shower of creamy blossoms when the vertiginous growth ceases.

As the shafts shoot higher and higher day after day, one is irresistibly reminded of the dreams of H. G. Wells, and the "Food of the Gods" does not, after all, seem so improbable. A cluster of aloe plants during the arrowing season, before the blossoms appear, resembles nothing so closely as giant asparagus.

Someone, however, will have to pay the piper for this agricultural debauch. The drought and low temperature of the past season have brought most of the aloes to maturity, and, as the plant dies after flowering, the aloe fibre industry is likely to feel the effects of the drought during the next two or three years to a considerable extent.

A. WALTER.

Quartre Bornes, Mauritius.
April, 1907.

Distances of Stars.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—The following suggestion may not be novel, but I venture to give it for what it may be worth.

It is often remarked how impossible it is to conceive the distances between the various worlds of the universe, but by adopting a scale that can be measured on our own world, the matter becomes comparatively simple.

Thus, there are said to be stars so remote from us that a man travelling at a speed of five hundred miles an hour could not reach them in less than five hundred millions of years. Few can realise the staggering figures, which appear to be 2,190,000,000,000,000 miles, but by using a scale of ninety-three million miles to one inch (the distance of the earth from the sun, a sort of astronomical mile as it were) such a star would, unless my arithmetic is at fault, be three hundred and seventy-one miles (English) distant.

By using the same method, the nearest fixed star would be only four and a quarter miles away.

Yours truly,
EDWARD C. DURNFORD.

Clyde River, Nova Scotia.

The Adulteration of Butter.

By C. HAROLD WRIGHT, B.A. (Cantab).

THAT butter is largely adulterated is well known. The subject has lately assumed additional interest, since a Bill to stop this fraudulent practice is now before Parliament. It is impossible to deal with the whole question in a paper like this. It will probably be thought that I have taken a very narrow view of the question. Having some experience of analysing commercial butters, it is the point of view which presents itself most forcibly to me; and as such, I hope it will be of interest to the reader.

Butter consists of water, curd, salt, and butter-fat. The most serious adulteration of butter consists in the partial or entire substitution of margarine or other fat for butter-fat. I may say, at once, that these foreign fats are not injurious; they are probably as nutritious as butter-fat. But, of course, one hardly likes to buy them at the price of butter; when desired they can be bought at their own price.

In order to understand the object of the proposed legislation it is necessary to describe the methods adopted in the analysis of butter. First, however, something must be said about the fats in general, and I will be as brief as possible. Fats and oils consist for the most part of mixtures of glycerides, *i.e.*, compounds formed by the combination of glycerin and acids with loss of water. The acids in the fats mostly belong to a class of acids called, from their origin, fatty acids; *e.g.*, stearic and palmitic, forming the glycerides stearin and palmitin. Acids belonging to other classes also occur, *e.g.*, oleic acid, the glyceride of which occurs in many fats and oils.

When fats and oils are heated with an alkali, glycerin is formed, whilst the acids combine with the alkali forming soap. Hence this process is called saponification, *i.e.*, soap-making. Thus, if beef fat, which is chiefly stearin, is saponified with caustic soda, we get glycerin and a soap which is chiefly sodium stearate. From the soap thus prepared the free acids can be liberated by adding a mineral acid—say hydrochloric acid—in excess; when prepared from hot soap solution they float as an oily layer, which solidifies on cooling. If the fatty acids, prepared from a known weight of fat or oil, are filtered and washed (whilst hot) till free from acidity, and finally dried and weighed, we can find the percentage of *insoluble* fatty acids in the fat or oil used. The majority of fats and oils contain about 95 per cent.; butter, on the other hand, contains from 87.5 to 89.5 per cent. By this means a genuine butter may be distinguished from a margarine or adulterated butter. Though not often used in the examination of butter-fat nowadays, it is of interest as being one of the first chemical methods of distinguishing butter from other fats.

Now, butter gives about the same percentage of glycerin on saponification as other fats and oils. What, then, is the missing constituent (or constituents)? It was found that if the fatty acids are washed (as described above) the wash-water in most cases contains only a trace of soluble *fatty* acid; whilst in the case of butter-fat there is a fair quantity of free *fatty* acid, which is chiefly butyric acid. It would take me too far afield to describe how the butyric acid is determined in the wash-water; it is sufficient to state that butter-fat contains 5 to 6 per cent. of soluble fatty acids, whilst most other fats and oils contain only a trace.

I have said that butter-fat differs from other fats and oils in containing a lower percentage of insoluble fatty acids and higher percentage of soluble fatty acids. It was afterwards discovered that the soluble (and some insoluble) fatty acids are volatile in steam. This is the *raison d'être* of the Reichert-Wollny process, which is the method generally adopted nowadays in the examinations of butter-fat for adulteration.

Briefly, it is carried out as follows :—Five grams of the butter-fat* is saponified with caustic soda, and the fatty acid liberated from the soap with sulphuric acid; the solution is then distilled (in a special apparatus) until 110 cubic centimetres of liquid have distilled over. This liquid is filtered and the number of cubic centimetres of caustic soda solution (of a particular strength) required to neutralise the filtered liquid is known as the Reichert-Wollny number.† For butter-fat it varies from 24 to 32, whilst for other fats and oils it is generally less than one; in some cases zero.

Besides differing from other fats and oils in chemical composition, butter-fat also differs from the other fats and oils (likely to be used as adulterants) in physical properties. The physical examination of butter-fat is frequently resorted to as a preliminary test; whilst it may raise a suspicion as to the genuineness of the butter, the proof of adulteration must always rest on a thorough chemical examination.

I said above that the Reichert-Wollny number for butter-fat varies from 24 to 32; this really only applies to the vast majority of butters. Sometimes butters, about the genuineness of which there is no doubt, have Reichert-Wollny numbers as low as 20, or even less.‡ These abnormal butters are of rare occurrence; nevertheless, they cause a great deal of trouble to the analyst. In this country the (unofficial) minimum limit is 24; if the Reichert-Wollny number of a butter falls below this limit it is generally considered to be adulterated. Still, the analyst has a lurking suspicion that it *may* be an abnormal butter. In the absence of any information as to its past history, it is often impossible to decide which of these suppositions is correct. Rather than condemn such a butter unjustly the analyst is often obliged to pass it, though it may really be adulterated.§

The Reichert-Wollny process is becoming of less and less value as a means of detecting adulteration. It is obvious that if a butter with a high Reichert-Wollny number be mixed with margarine, or other fat of low Reichert-Wollny number, it is quite possible to prepare a mixture which would pass *this* test as a butter; this is done to a large extent with full knowledge of the methods of butter analysis.

The analyst's difficulties have lately increased, owing to the use of cocoanut oil as an adulterant. This oil has a fairly high Reichert-Wollny number, about eight, and it is only by a combination of tests that it is possible to detect this form of adulteration.

* The butter-fat is prepared for analysis by warming some butter in a steam oven, when the fat rises to the surface as a clear oily layer; this is poured on a dry filter-paper, and filtered whilst hot.

† Full details for carrying out this process are given in the Schedule to the Report of the Departmental Committee on Regulations for Butter, 1903. (Official Publication, Cd. 1749)

‡ These variations in the composition of butter-fat are due to climatic conditions, period of lactation, nature and amount of food, breed and idiosyncrasy of the cow. See report on Regulations for Butter (referred to above), where the subject is fully dealt with.

§ It must be pointed out here that other tests besides the Reichert-Wollny process are used; some of these, *e.g.*, the determination of soluble and insoluble fatty acids, have been referred to above.

Lest I seem to exaggerate I give the following quotation from Dr. Lewkowitch's "Oils, Fats, and Waxes" (1906), p. 841 :—"The butter adulterator keeps within the limits of such chemical tests as are from time to time agreed upon by analytical chemists, and hence prepares on a large scale adulterated butters, which just keep near the lowest limits, so that the analyst is very frequently placed in the position of having to give the butter 'the benefit of the doubt,' although he may feel convinced that adulteration has taken place."

At present the most important enactment regulating the trade in butter is the Sale of Foods and Drugs Act. The essential principle of this Act is that nothing shall be sold to the prejudice of the purchaser, which is not of the nature, substance, and quality demanded. Inspectors, or other officers appointed by the local authority, take samples of butter (besides other foods), which are sent to the public analyst for examination. If the butter (or other food) is adulterated, proceedings are instituted against the vendor. But I have already shown that the analyst is often unable to detect adulteration, when carried out on scientific principles. How, then, is this adulteration to be prevented? Clearly, it is no use waiting to take action till the adulterated butter is already on the market; action must be taken to *prevent adulteration taking place.*

This is what the Butter and Margarine Bill* introduced by Sir Edward Strachey proposes to do. Under this Act all butter factories, or any premises on which there is manufactured any butter substitute, must be registered (as margarine factories are at present). Any officer of the Board of Agriculture and Fisheries and any officer of the local authority (if specially authorised) shall have power to enter any registered factories to inspect any process of manufacture, and to take samples for analysis of any butter, margarine, &c.

Clause 3 is of special interest. It is, "If any substance intended to be used for the adulteration of butter is found in any butter factory, the occupier of the factory shall be guilty of an offence under this Act, and if any oil or fat capable of being so used is found it shall be deemed to be intended to be so used, unless the contrary is proved."

The other sections relate to subjects beyond the scope of this paper; the final section, 10 (2), is, "This Act shall come into operation on the first day of January, one thousand nine hundred and eight." It is earnestly to be hoped—in the interests of farmers, honest retailers, and last, but not least, the general public—that this will be so.

Answers to Correspondents.

C. C. S. (*Edinburgh*).—In answer to your inquiry, it may be mentioned that the cockroach, or "black beetle," commonly found in this country, is *Stilopyga orientalis*, an introduced species, of which the original habitat is unknown. These insects breed freely in crevices and holes in kitchens, etc. Numbers may be destroyed with Keating's insect-powder, or cucumber peel; but either of these substances should only be put down for a few nights consecutively, as otherwise the insects avoid them. Special traps are also effective. Another method is to introduce a strong light after the kitchen has been closed for the night, when the cockroaches will come out in myriads, and may be stamped upon and swept up.

* This Bill closely follows the recommendations of the Select Committee on the Butter Trade, 1906. (Official Publication, 245.)

XUM

The Periodical Comet 1881 V.

By W. F. DENNING.

A RETURN of this comet being now due, a rough, sweeping ephemeris has been prepared by Dr. Smart, of Bermondsey, S.E., and as some of your astronomical readers may be inclined to search for the object, I append the positions for September.

The comet must have been a naked-eye object in August, 1881, when, however, it was only visible from the southern hemisphere. It was not discovered at Bristol until the morning of October 4 of that year, when it was three weeks past its perihelion and had become rather faint, its distance from the earth being then 71,000,000 miles, whereas, during the first week in August, it was only 11,000,000 miles.

The comet should have returned in the spring of 1890 and in the early part of 1899, but the circumstances were all opposed to its detection on those occasions. The ensuing return promises, however, to be a repetition of the favourable apparition of 1881, when it was unfortunate that only 37 observations were secured, the increasing faintness of the comet not allowing it to be observed after November 24.

The orbit was investigated by Plummer, who deduced a periodic time of 8 years and 315 days, while Hartwig made it 8 years and 304 days, and Matthiessen 8 years and 251 days. It forms a notable object among the Jovian family of comets, for the fact that at one portion of its orbit it approaches to within 3,300,000 miles of the earth's path.

EPHEMERIS FOR GREENWICH MIDNIGHT.

1907.	R.A.	DEC.	LOG. Δ	LIGHT.
	h. m.	° ′		
Sept. 4 ..	6 44·5	+ 17 50	9·876	1·58
,, 8 ..	7 13·1	+ 17 57	9·885	1·66
,, 12 ..	7 44·7	+ 17 50	9·897	1·71
,, 16 ..	8 13·6	+ 17 28	9·912	1·74
,, 20 ..	8 40·8	+ 16 50	9·930	1·72
,, 24 ..	9 6·6	+ 15 59	9·951	1·67
,, 28 ..	9 30·9	+ 14 58	9·973	1·58
Oct. 2 ..	9 53·7	+ 13 49	9·995	1·47
,, 6 ..	10 15·3	+ 12 33	0·017	1·34

Assumed perihelion passage October 6.

What is Nitrogen Iodide?

AFTER the recent disastrous explosion at Woolwich Arsenal on February 22, it was repeatedly stated that the explosion was originated by the detonation of a small quantity of nitrogen iodide. This rumour obtained wide credence until, in reply to a question by Mr. Lyulph Stanley, Mr. Haldane stated in the House of Commons that none of this substance was at the time in the laboratory at Woolwich. Several correspondents have asked us what nitrogen iodide is; and by a coincidence a correspondent, "E.B." (Chertsey), has written us a short note on it.

Nitrogen iodide is a substance formed whenever iodine and a solution of ammonia are brought into contact. If iodine, dissolved or in powder, is brought into a solution of ammonia the two at once interact, and a black, insoluble substance is produced. This is nitrogen iodide. As usually made, it is a black powder, which may be kept quite safely under the surface of a weak solution of ammonia, but which is extremely dangerous when filtered off and dried, as it then explodes sharply on the slightest touch, or if a particle be let fall upon the floor. It is a common, but somewhat alarming, experiment of mischievous boys beginning the study of chemistry to place small pieces of the substance while moist on door handles or floors, where, after drying by evaporation, it explodes with a loud report on being accidentally touched by a chance passer by. There is no doubt, if any of this dangerous material were allowed to become dry in the neighbourhood of explosives at Woolwich, that a chance detonation of a small fragment might have disastrous results by inducing the explosion of the unstable high explosives now used in warfare.

The question of the chemical nature of nitrogen iodide engaged the attention of some of the greatest chemists of the past century, among others, that of Gay Lussac, Davy, and Bunsen, as well as of Schönbein, the discoverer of gun-cotton, but it was not until some six years ago that the puzzle was solved. The substance is so unstable, and so difficult to prepare quite pure, that it was commonly believed that a whole number of similar but distinct compounds existed, and the matter was not cleared up until Chattaway, an English scientist, in a series of articles which appeared in the "American Chemical Journal," proved that these supposed different substances were all more or less impure varieties of one single definite substance, and showed how to prepare this in a pure state. He also showed how the compound could be prepared in large quantities and worked with in safety.

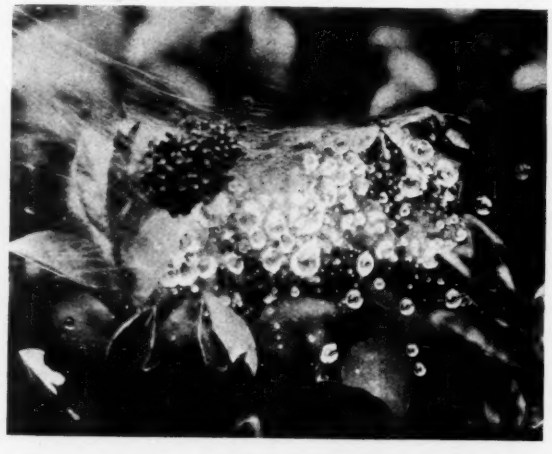
Nitrogen iodide is far too unstable to receive any practical application as an explosive, either for blasting or war, and still remains what it was when originally prepared—about the time of the battle of Waterloo, by a French chemist, Courtois—a scientific curiosity.

Spiders' Nests.

A correspondent sending the photograph of a spider's nest, writes:—"I have lately found much interest in watching spiders, especially in their earliest stage of existence, as shown in the accompanying photograph.

It shows a nest of newly-hatched garden-spiders, on a dwarf privet hedge, life-size. They are extremely difficult to photograph, being generally in a position where the camera cannot be brought to bear, or else in bad light.

It is not snap-shot business, as the lens must be brought as close to the subject as possible, and the stop down to *f*/22, with two seconds exposure, in brightest sunshine. There is a slight but unceasing motion of the whole mass, rendering sharpness of detail impossible.



These nests appear quite suddenly with the first hot weather, hanging on to a leaf exactly like bees swarming.

The young spiders are very minute, not larger than the head of a small pin; and a light orange colour, but able to spin threads eight or more inches long, as illustrated.

If disturbed, they scatter in a leisurely way, without any of the excitement manifested by ants so treated, and soon re-assemble in the same spot.

They disappear after three or four days as suddenly as they arrived, and then it is curious what becomes of them all. Not a trace of a spider or a web is to be found anywhere near for some weeks to come. Where are they meanwhile, and what do they live on?"

Photography: Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

The Sensitiveness of Plates.

Some idea of the sensitiveness of photographic plates is necessary as a guide to the purchaser, but it is a mistake to suppose that the comparative sensitiveness (or speed) is an inherent quality or can be definitely expressed. Sensitiveness is definite only when the treatment of the plate and what it is sensitive to have been exactly defined. Daylight is generally taken as the standard light, and rightly so, because it is the light most generally used, but as daylight is variable in quality, relative sensitiveness to it can never be expressed other than approximately. Between the sensitiveness of two plates, one of which is twice as sensitive as the other, there may be two or three degrees of sensitiveness that can be distinguished with care, and that will sometimes be of practical service in general work. For more exact estimations the light must be more definite than "daylight" (though it may be less generally useful), and the estimations must be made with unusual care.

Among the numerous scientific and pseudo-scientific writings and workings on this subject, there is one item in particular that I should like to take objection to, namely, the standardising or making uniform of the details of the methods by which relative sensitiveness is estimated. A certain "standard" developer is applied for a uniform time at an invariable temperature, and then the results are supposed to show the comparative sensitiveness of the plates tested. But the way to estimate the real sensitiveness is to get as much as possible out of every plate, whatever the developer and whatever the time necessary. If a plate requires special treatment it should receive it. If one plate is specially responsive to a certain developer, the result it gives with a "standard" developer may be a quite false measure of its available sensitiveness. If the "standard" time for development is ten minutes and a certain plate does not show full detail in less than fifteen or twenty minutes, the "standard" method will never give a true indication of its sensitiveness. The user of a plate wants an intelligible statement of what it will really do, and cares nothing for what it will do under certain "standard" conditions. If we want a message conveyed quickly, we do not specify that the messenger must walk or run in any special or "standard" way. We do not cling to our coaches now that motor cars and trains are available, nor do we insist that these latter shall be drawn by horses, like the coaches, when comparing the rapidities of the various methods of transit. I venture to repeat here what I said when standardised methods of treatment were first introduced for the general estimation of plate sensitiveness, namely, that though uniformity may be convenient to the one who does the tests, it is not only uncalled for, but it may lead to very deceptive results.

Lumière's Autochrome Plates.

I have not referred to these since nearly three years ago, because, although it has been well known that Messrs. Lumière have been constantly at work seeking to perfect their manufacture, very little of general interest has transpired. The plates are now on the market in France, and we are told that they will appear in this country as soon as the makers can overtake the demand on the Continent. To put the matter concisely, they are prepared by staining starch granules of nearly uniform size, red, green, and violet, mixing them in such proportions as give a neutral grey, and spreading the mixture on glass in a layer one granule thick. The layer is pressed so that the granules may be caused to fill up the minute interstices that at first exist because of their shape, and coated with varnish. On this is spread a layer of a colour-sensitised emulsion. Exposure takes place through the glass, so that the coloured layer of granules acts as a parti-coloured screen, and a suitable coloured screen is used at the lens to compensate for the deficient colour-sensitiveness of the emulsion. After development, the plate is not fixed, as the image is negative, and a positive image is required. The silver image is therefore dissolved out, and the remaining silver salt is reduced to form the image. There thus remains a grained three-colour transparency, but with a grain so fine that it is invisible to the naked eye.

Photometry—Photographic and otherwise.

From time to time suggestions are made to directly apply photographic methods to ordinary photometry, that is, the measurement of the comparative luminosities of various lights, and arrangements have sometimes been described in detail with the idea of getting more exact results than the ordinary methods generally yield. There is, of course, no photographic plate that will serve for measuring luminosity, just as there is no human eye that can compare what is so indefinitely called the actinism emitted by two sources of radiant energy. Whatever the sensitive material employed, it can deal only with those kinds of radiant energy to which it is sensitive, and in the proportions in which it is sensitive to these. "Luminosity" and more particularly "actinism" have no quantitative significance in themselves, and become definite only when they are associated with a definite sensitive material. Silver chloride will not serve to measure actinism in general, and the human eye becomes a valid instrument for comparing luminosity only when luminosity is defined as the effect produced upon the human eye. The principle of testing lights by means of the very thing that they are required to act upon should be very rarely departed from, and then only with the greatest circumspection.

There is, perhaps, what may appear at first sight to be an exception to this general principle in the measurement of the absorbing or obstructing power of media. If the medium to be measured is free from selective absorption (that is, so far as the eye is concerned, is free from colour) then it does not matter whether white or coloured light is used, or whether photographic or ocular methods are employed. But work of this kind is, I think, not properly called photometry, because the measurement of the light is merely a secondary matter, and the intensity and character of the incident light is a mere matter of convenience. If the medium to be measured is not free from colour (or selective absorption) then its absorbing power can be only vaguely expressed unless the character of the incident light and sensitive material are given as the conditions that determine the absorptive power found.

XUM

Practical Aerodynamics and the Theory of Aeroplanes.

By MAJOR B. BADEN-POWELL.

VII.—THE PRESSURE OF THE AIR ON INCLINED PLANES—(*Continued*).

To go back a step, it may be useful to quote a table of the resistances and pressures to which a plane is subjected when set at a given angle of inclination. We have seen how Duchemin's formula

$$p = P\frac{2 \sin \alpha}{1 + \sin^2 \alpha}$$

seems to be about correct, and the following table (extracted from a more complete one in Chanute's "Progress in Flying Machines") is based on this formula. The total force acting on the plane, according to this, may be split up into the vertical force acting in opposition to gravity, or "lift," and the horizontal force which has to be overcome by the propelling agent in order to obtain that buoyancy, called "drift."

Angle of Inclination. Degrees.	Lift.	Drift.	Angle of Inclination Degrees.	Lift.	Drift.
1	·035	·0006	12	·392	·083
2	·070	·0024	13	·419	·097
3	·104	·0054	14	·443	·115
4	·139	·0097	15	·468	·124
5	·173	·0152	20	·575	·210
6	·206	·0217	25	·650	·304
7	·238	·0293	30	·693	·400
8	·270	·0381	35	·708	·498
9	·300	·0477	36	·709	·516
10	·332	·0585	40	·697	·586
11	·362	·0702	45	.666	·666

It may be noted that the greatest actual lift occurs when the angle is 36°, and that at greater angles the lift decreases again.

To give a practical example of the use of this table, let us suppose we have a plane of 500 square feet surface propelled by mechanism giving it a speed of 30 miles an hour. This rate would cause a pressure of 2.7 lbs. per square foot if the surface were perpendicular to the line of advance (according to the table of wind pressures already given). This would equal a total force of 1,350 lbs. But, now, suppose the plane to be inclined to 5°. The lift would then be .173 of 1,350, or 433 lbs. The drift or necessary thrust of the propeller would be .0152 of 1,350, or 20.5 lbs. It must be remembered that is only taking into account the theoretical resistance of the inclined plane, and does not include the resistance offered by the body or mechanical structure of the apparatus.

Langley investigated the subject of inclined planes with two different forms of apparatus. The "Plane Dropper" has already been referred to. The "Component Pressure Recorder" consisted of a plane surface fixed at any desired angle of inclination on the arm of the whirling table. When given a rapid velocity the plane rose and became supported on the air, and directly this occurred the speed of translation was noted. This is known as the "soaring speed" of the plane. The planes tested were of different shapes, but all weighed just over 1 lb. per square foot; 30° to 35° was found to be the angle at which most of the planes soared with the least speed (about 33 feet per second), but with very small angles far higher speeds were necessary to obtain a lift. With an inclination of only 2° the velocity required was over 65 feet per second.*

As regards the form of plane, it was found that at angles less than 20° a lower speed sufficed to lift an oblong plane having its longer side foremost than one end on, at greater angles the reverse occurred. The lowest soaring speed for the former shaped plane was obtained when the inclination was 25°, but for the latter, 35°. This is an important fact to note in the design of aëroplanes. A wide and short one soars when at a flatter inclination than a narrow and long one. Later on we will consider the requisite amount of thrust to drive the planes when inclined at various angles.

In the experiments on inclined planes conducted for the Aëronautical Society in 1871 (*7th Report of the Aëronautical Society*) it was found that "whether the exposed surface was a circle, a square, or a parallelogram, providing the area was the same, the results were identical to the degree of accuracy to which the readings could be determined."

Here also an oblong plane 4½ by 18 ins. with edge to the wind current gave a greater vertical force than when end on.

(*To be continued.*)

Cold in Relation to the Moon.

IN the April number of "KNOWLEDGE & SCIENTIFIC NEWS," Mr. A. B. MacDowall pointed out that the week about full moon in December is usually relatively cold.

In the June number "J. L. J." asks how this applies to the Southern Hemisphere, suggesting that our midsummer full moon might have a corresponding change to their midwinter full moon.

I have looked up some figures which seem to show rather remarkable results, though I have only three years' figures to go upon.

Taking the average temperatures for three days, that is, for the day before, the day after, and the day of full or new moon, in December I find--

December	1903.	1904.	1905.
Full moon (average of 3 days) ...	35	30	34
Average temperature for 50 years on those days	41	39	40
New moon (3 days)	40	38	37

Now, taking the figures for June, we get:

June	1903.	1904.	1905.	1906.
Full moon	55	58	62	53
Average temperature for 50 years	58	62	59	58
New moon	62	60	64	68

—that is to say, in every case taken, it is colder at full moon than at new moon.

Some other months I have tried, however, do not seem to fall in with this theory.

B. BADEN-POWELL.

* It may be noted that this result is not quite in accordance with the table just given, although the others work out right.

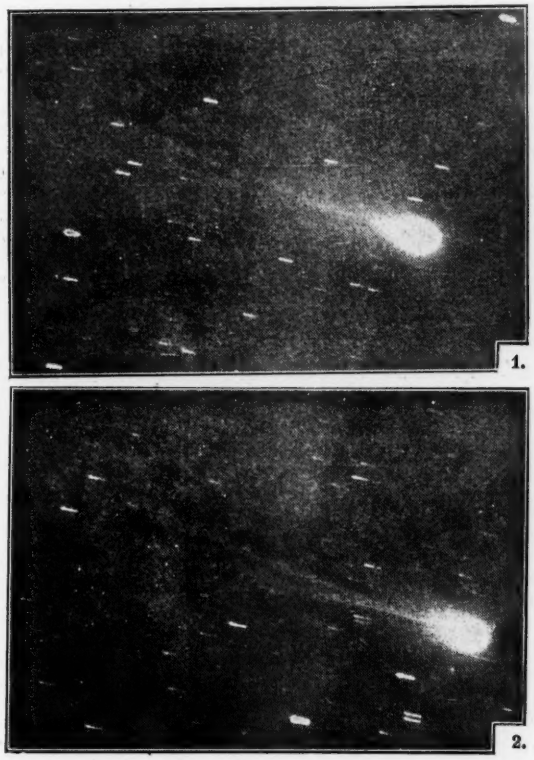
NOTES.

ASTRONOMY.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Comet Daniel (1907 d).

IN spite of its somewhat unfavourable position, being visible only a short time before sunrise, and then only in the grey eastern sky, this comet has proved of very considerable interest. The later ephemeris proved to be very correct, and enabled the object to be easily detected with an opera glass until its brightness was sufficient to permit of its easy detection with the unaided eye. Telescopically, it is exceedingly intricate in structure, there being an oval nucleus



(From *Bulletin Astronomique.*)

Photographs of Comet Daniel (1907d) taken on the 19th and 20th July, 1907, by M. Quenisset, at the Juvisy Observatory.

surrounded by one or more sheaths of nebulosity, and several tails, apparently of the straight type, radiating from the head. It is announced that a photograph obtained at Greenwich shows four tails, while others obtained by M. Quénisset, at the Observatory of Juvisy, show that the comet had five tails on the 19th of July, and seven on the 20th of July. The nearest approach to earth has been variously computed as August 1 or 3, and the greatest brightness as on August 21, about a fortnight before perihelion. It is now as easily visible as a star of 2.5 magnitude, but from its different nature the comparison is of course only approximate. From the small inclination of its orbit and other details, it is possible that this may be a member of the Jupiter family of short period comets.

Although the north declination is now again decreasing, it is probable that the comet will be visible in the early evening, after passing the sun on September 4.

Its position on September 1, will be :—

R.A. = $8^h\ 50^m\ 44^s{\cdot}89$; Decl. = $13°\ 34'\ 38''{\cdot}6$.

Venus as a Luminous Ring.

Messrs. H. N. Russell and Z. Daniel describe their observations of this rare and interesting phenomenon, made at the last favourable conjunction in 1906, at the Princeton University Observatory, using the five-inch finder of the 23-inch refractor. On November 29, at 5h. 7m., G.M.T., the planet being only about 1° 49′ from the sun's centre, it was possible when the air was steady to see the complete outline of the planet. On the side nearest the sun it was bright and easily visible, but on the opposite side it was very faint, and could be seen only for a few seconds at a time. When the complete circle was seen, the space within it always appeared a shade darker than that without, but it is possible that this was a subjective effect, as it was not noticed when the fainter part of the ring disappeared through bad seeing. The only other peculiarity noticed was a bright spot suspected several times in the bright part of the ring. From measurements of the extent of the crescent with a filar micrometer the length of the twilight arc in the atmosphere of Venus was determined to be about 60′, which agrees fairly well with the value of 70′ found from the observations made in 1898.

The ring phase of Venus may perhaps be visible again in 1914, if the atmospheric conditions are very favourable; after then there will be no further opportunity until 1972. (*Astrophysical Journal*, Vol. 26, p. 69, July, 1907.)

Solar Parallax.

The discussion of the photographs of Eros taken at Greenwich during the opposition of 1900-1901 having been completed, it has been decided to deduce the solar parallax from them separately before the final combined value is determined from the joint international discussion. There were in all 197 photographs taken with the astrographic 13-inch refractor, and 153 taken with the Thompson 26-inch refractor, between October 1, 1900, and February 25, 1901, but for the discussion of the solar parallax, only those taken during the period October 14, 1900, and January 18, 1901, have been considered. Ten to twelve "reference" stars and six "comparison" stars were measured with Eros on each astrographic photograph, and these two sets of measures are discussed separately. The reference stars selected from Loewy's list are all brighter than the ninth magnitude and therefore brighter than Eros, while the comparison stars are of approximately the same brightness as the planet. The determination of the movement of Eros in the interval between the groups of photographs compared was first undertaken, using a provisional parallax of 8″.800. From the combined discussion of the two series of photographs, using comparison stars only, the deduced value of the solar parallax is—

$8''{\cdot}800 \pm 0''{\cdot}0044$ from right ascensions
and $8''{\cdot}801 \pm 0''{\cdot}016$ from declinations.

(*Monthly Notices*, R.A.S., Vol. 67., p. 380.)

North Polar Cap of Mars during 1907.

At the beginning of the present year's observations of the recent opposition, on March 22, at Flagstaff, Arizona, the North Polar cap of Mars could just be seen as a small white spot at the edge of the northern part of the disc, being thus of its smallest dimensions, probably the old polar cap of the winter before. It continued in this form until well into April, its diameter during the interval varying from 8.5 to 7.1 degrees. On April 8, a large white patch appeared to the left of it, extending southwards, marking the first frost of the approaching Martian autumn. Patches of great size in and about the arctic regions were numerous during the next fortnight, until about April 21 the cap settled down to a permanent increase of snow-covered area.

XUM

The limiting latitudes of the edge of the cap varied from 49° N. to 68.5° N. from this date, up to June 14, and from an analysis of the variations of this limit during the interval it appears that the cap began in the same sudden and extensive manner that had characterised its advent in 1903 and 1905. To account for this and other peculiarities of the cap formation, Professor Lowell has made an analytical computation of the daily insolation upon a planet, and applying the formulæ to the case of Mars, whose axis inclination to the ecliptic is adopted as 24°.0, he finds there is a distinct maximum of insolation at the summer solstice at the North Pole of Mars, with a second maximum of rather smaller amount in mid-temperate latitudes (N. lat. 44°.5). This is a similar effect to the accentuation of the insolation in the polar regions during the summer months on the earth, but it is much more pronounced on Mars, and this is most probably the cause of the great melting of its polar caps.

From the solstice to the equinox, there is a gradual change in the positions of maximum insolation, so that at some date between these times the values of the insolation will be identical at the pole and at 60° N. latitude. This occurs on a date corresponding to our August 3. Professor Lowell thinks this fact may account for a most curious Martian phenomenon. When the cap begins to form in the autumn, it proceeds to develop, not by successive slow increments to the edge of the old kernel, but by a sudden light deposition of frost, extending down the parallels to about latitude 60°, enveloping a vast region in its fall. This has now been repeated for three consecutive Martian years. Having thus been deposited, the frost is melted in part, to be followed in a few days by a heavier fall, extending farther down, thus building up the cap by waves of recession and advance. It is also noted that the actual equalisation occurs about August 22-23, instead of August 3, as computed, and this retardation is thought to furnish additional evidence for the existence of a Martian atmosphere of considerable extent. Although the mean temperature of Mars (48° F.) is less than ours (60° F.), it is probable that the arctic and antarctic regions of Mars are actually warmer in their summer than are ours, owing to the greater length of the Martian year.

BOTANY.

By G. MASSEE.

Nature and Significance of Sexual Differentiation in Plants.

PROFESSOR BLAKESLEE has discussed this question in *Science*. The sum-total of facts suggests that nothing is effected by sexuality that cannot be equally well effected by non-sexual methods of reproduction. Non-sexual forms are quite as vigorous as sexual ones, sometimes more so, as in the case of sexual moulds being swamped by non-sexual forms of *Penicillium*, &c. Distinct varieties often arise asexually that cannot be distinguished from varieties obtained from seed. It seems probable that many of the higher plants, as the dandelion, etc., have dispensed with sexual reproduction, and reproduce themselves pathogenetically without any loss of vigour. There is considerable difference of opinion as to what constitutes a sexual act. A blending of nuclei precedes the formation of so-called apogamous embryos in certain plants, and appears to take the place of a typical sexual process. The limits within which growth is possible are wider than the limits within which reproductive bodies can be produced; in other words plants will grow under conditions where sexual reproduction is impossible. In *Sporodinia*, non-sexual spores are alone produced where there is a scarcity of nutriment, whereas zygospores, the result of a sexual act, are produced when the nutrient material is concentrated. Again, the conditions under which male and female reproductive organs are produced do not always coincide. Light alone is an important factor in this respect in some instances. The prothalli of homosporous ferns under a minimum of illumination continue to grow in a vegetative manner, both male and female organs being suppressed. When the light is increased to a certain amount male organs only are produced, whereas with a still greater amount of illumination female organs are also produced.

A Blazing Beach.

Professor Penhallow has given an account in *Science Monthly* of a remarkable occurrence that happened at Kittery Point, Maine. The portion of beach where the conflagration happened is about 200 feet long, and is hemmed in on either side by rocky ledges, and is made up of pebbles, changing to sand between tide-marks. The blazing occurred in the evening, and lasted for over half-an-hour. It was accompanied by a loud crackling noise, which could be heard one hundred yards away, due to the explosion of bubbles of gas as they came to the surface. The fire occurred over that portion of the sand left exposed by the tide, and also extended over the water for a distance of thirty or forty feet. There was a great liberation of sulphurous acid gas, which caused the occupiers of an adjacent hotel great inconvenience. The heat developed was so great that the sand could not be held in the hands. When sand was placed in a tumbler mixed with water, and then stirred, bubbles of gas escaped, which ignited on coming into contact with the air. A second conflagration also occurred at the same spot. The author considers that the most probable explanation of the origin of the gas is from the decomposition of organic remains buried under the portion of beach indicated, which forms a sort of pocket enclosed by rocks on either side, into which large quantities of *Zostera*, algæ, and animal remains are being constantly deposited and silted over. A shock of earthquake which occurred the day previous to the first conflagration probably enabled the accumulation of gas to escape. It is further suggested that the charred wood found in various geological deposits, as in the cretaceous rocks in Staten Island and elsewhere, was not deposited in the burnt condition, but that combustion took place after the wood was deposited. Many obscure forest fires commonly attributed to lightning, &c., may also possibly be accounted for on the lines indicated above.

Respiration of Seeds.

Experiments on the respiration of seeds in a dry or resting condition have been described by P. Becquerel in *Comptes Rendus*. Generally speaking, seeds in the dry state, when kept in the dark, give off a trace of carbonic acid gas and absorb a small amount of oxygen. This gaseous exchange is greater when the seeds are exposed to light, owing to its power of favouring oxidation. The testa of the seed is an important factor in determining the rate of respiration. In *Ricinus* the gaseous exchange was higher in the testas alone than in the seeds from which they had been removed. Dehydration also plays an important part, and in some instances no gaseous exchange took place in the absence of moisture.

Abnormal Germination in Fucus.

E. Küster has described in *Ber. Deutsch. Bot. Gesell.* some experiments bearing on the germination of the fertilised spores of *Fucus*. In typical cases only one rhizoid papilla is formed, but there are exceptions to this rule, which the author considers to be due to osmotic disturbances; it is further stated that the determination of the place at which the papilla of the rhizoid shall appear is possibly due to certain osmotic conditions in the oospore.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

Distribution of Odoriferous Constituents in Plants.

IN continuation of their work upon this subject, MM. Charabot and Laloue have found that the relative solubility of the different constituents that form the scent of a plant is an important factor in the distribution of those substances among the different organs, and more especially between

the blossoms and the leaves and stems. In the case of vervain (*Verbena triphylla*), the plant selected for most of their experiments, the chief substances in the essential oil (to which the odour is due) are myrcene, geraniol, citral, and verbenone. Now, the essential oil from the leaves and stems is more soluble in water than the oil from the blossoms, which is characterised by containing a much larger proportion of citral. It would seem that the geraniol first formed in the green parts of the plant is partially converted into ethers, and then transformed by oxidation into citral. When the plant flowers, a relatively soluble fraction of the essential oil appears to reach the blossoms by osmotic action, and the reactions that take place there favour the formation of citral, and thus tend to increase the relative solubility of the oil. In the course of inflorescence, however, the destruction of odoriferous constituents furnishes part of the energy required for the work of fertilisation, and it is chiefly the citral that disappears, probably by way of oxidation.

Scientific Examination of Handwriting.

In a recent article upon the examination of handwriting ("KNOWLEDGE & SCIENTIFIC NEWS," this volume, p. 147), the present writer called attention to the fact that little use had as yet been made in the law courts of scientific methods of distinguishing between the inks used in different specimens of writing. By a curious coincidence this article appeared almost simultaneously with the first occasion in which evidence of this kind has been given in an English court of law. It may be remembered that in a recent notorious poisoning case, it was alleged by the prosecution that a will had been forged, and that the signature of one of the witnesses had been obtained by fraud. This witness asserted that he had signed a paper, late at night, in a public-house, without knowing it to be a will; and in order to test his statement, the particular ink from that public-house was obtained, and he was asked to sign his name with it upon a sheet of paper. The signature upon the will and upon this paper were subsequently submitted to scientific examination, and at the trial evidence was given that they were written in the same kind of ink, which was totally different from any other ink upon the will. It was also proved that the body of the will and the signature of the other witness were both written in another kind of ink, and that the signature of the testatrix had been written in yet a third kind; so that in all three sorts of ink had been employed. When asked to explain this fact, the prisoner asserted that three kinds of ink had been kept in the house, but brought no evidence in support of his statement. The will had been disputed, and this supplied the motive for the attempt to poison the witness, whose signature had been written in the public-house, and without whose silence the prisoner would have been unable to prove his title to the money.

Ancient Egyptian Mordants.

When a fabric is dyed with a soluble colouring matter it sometimes happens that the fibres, especially those of animal origin, enter into combination with the colour to form an insoluble compound, which is not removed by washing. Thus, silk may be dyed with indigo by being dipped in a solution of the dyestuff in sulphuric acid, and the colour becomes firmly attached to the fibres without the necessity of using any fixing agent. But, when, as is usually the case, there is no strong attraction between the dye and the substance of the fibre, it is essential to employ some substance, termed a *mordant*, which will combine with the colouring matter and render it insoluble in water. For instance, if cotton be dipped in a solution of cochineal and dried, the colour is removed the first time the fabric is washed; but by boiling the material with a solution of aluminium acetate before the dyeing alumina is deposited within the fibres, and this combines with the dye-stuff to form an insoluble lake, which is not removed by washing. There are numerous other mordants employed, which are selected according to the nature of the particular dye, but the general principle of their action is the same, viz., formation of insoluble pigment within the fibres. The investigations of MM. Scheurer and Gilliéron have shown that some preparation of tin was used as a mordant by the ancient Egyptians. It is not improbable that this was a basic tin citrate, dissolved in a solution of alum, for the yellow dyestuff of Persian berries yields a particularly brilliant lake upon wool when treated with that reagent. Alum and tin were both known to the ancient Egyptians, and the basic tin salt could readily have been prepared by the action of lemon juice upon the metal in the presence of air. The tapestries made by the Coptic dyers of the eighth century, A.D., and discovered in the tombs at Antinoa, also contain tin, and it is probable that in that case, too, a mixture of a tin salt with alum had been used as the mordant.

Decolorising Property of Graphite.

Powdered graphite or plumbago, which in its crude state contains about 79 per cent. of elementary carbon, has been found by Herr Rosenstiehl to have a marked decolorising action upon a solution of litmus, though the same graphite when purified so as to contain 93 per cent. of carbon is less active. The well-known decolorising power of animal charcoal is reduced by the presence of alkali, whereas the action of purified graphite is not affected by the addition of a small proportion of acid or alkali. The presence of graphite in a liquid which is oxidised on exposure to the air increases the speed of oxidation, but the decolorising power appears to be independent of any oxidising process.

GEOLOGY.

By EDWARD A. MARTIN, F.G.S.

System-Names and Break-Names.

THE names which our geological systems bear are not the best that could now be selected, if it were necessary or desirable to name them afresh, in the light of modern geology. Attempts have been made from time to time to introduce names which might be more appropriate, but without any great success, and it may now be accepted that the titles the systems bear will remain. Possibly, if a new nomenclature were to be adopted, some would disappear, as the breaks between one and another have in certain cases been bridged over by rocks discovered since the names were adopted. Sometimes the "bridging" strata have come to light in our own country, but in other cases these have been found abroad. In speaking of times intervening between one formation and another, we have no titles which in a single word would express these possible breaks, and such titles would, as it seems to me, be of great use both in speaking and writing. Frequently a deposit is found about which for some years there is great difference of opinion as to where it should be placed, and for the time-being it could be relegated to the intervening period, now to be known by a single term. The following terms are suggested, due prominence being given to those geologists who have become conspicuous in connection with their work on rocks of the age nearest to the intervening periods:

PLEISTOCENE AND RECENT	PERMIAN.
Harmerian.	Davidian.
PLIOCENE.	CARBONIFEROUS.
Newtonian.	Binneyan.
MIOCENE.	DEVONIAN.
Cuvierian.	Millerian.
OLIGOCENE.	SILURIAN.
Juddian.	Lapworthian.
EOCENE.	ORDOVICIAN.
Whitakerian.	Marrian.
CRETACEOUS.	CAMBRIAN.
Woodwardian.	Wattsian.
JURASSIC.	KEWEENAWAN.
Seeleyan.	Teallian.
TRIASSIC.	PENOKEE.
Sillimanian.	Dawsonian.
	HURONIAN.

It is the regret of all that next to nothing is known of

that portion of earth-history that was being "made" far away from centres of water-deposition, and although in the course of time many of the gaps will be filled in by discoveries somewhere on the globe's surface, yet in their absence in Great Britain, it would be of the greatest convenience if such gaps could be known by certain generally-recognised names.

Zones of the Chalk.

As promised last month, we give now some illustrations of the rarer chalk fossils. It may be convenient here to show how the chalk has been in recent years divided into zones, each zone bearing the name of a fossil particularly associated with it, although such fossil may not be exclusively confined to the zone.

(Danian) Faxoe Limestone, Pisolitic Limestone, Maestricht Chalk.

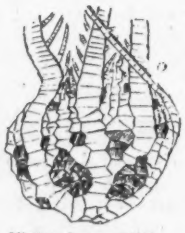
Upper Chalk (Senonian)	zone of	*Belemnitella mucronata.*
	,,	*Marsupites.*
	,,	*Micraster cor-anguinum* and *M. cor-testudinarium.*
Middle Chalk (Turonian)	zone of	*Holaster planus* ("Chalk Rock").
	,,	*Terebratulina gracilis.*
	,,	*Rhynconella cuvieri.*
	,,	*Inoceramus labiatus* (Melbourne Rock).
Lower Chalk (Cenomanian)	zone of	*Belemnitella plena.*
	,,	*Ammonites rhotomagensis.*
	,,	*Holaster sub-globosus* (Grey Chalk, Totternhoe Stone at base).
	,,	*Ammonites varians.*
	,,	*Plocoscyphia meandrina* (Chalk Marl).

It may conveniently be added that the old arrangement of dividing the chalk into Chalk with Flints and Chalk without Flints has now been quite abandoned, as it was clearly inaccurate in some districts, whilst the Chalk Rock and the Melbourne Rock make clearly-dividing lines between the three divisions now shown. An alternative fossil for the zonation of the Chalk Rock has been suggested in *Heteroceras reussianum.*

"Grey Wethers."

An attempt is being made to purchase by public subscription eleven acres of land in Pickle Dean and nine acres in Lockeridge Dean, in order to preserve the chief portions of those collections of Sarsen-Stones which are scattered over the Marlborough Downs. These stones are of great geological interest since they are the harder portions of strata of eocene age which formerly covered the chalk, which in the course of ages has been denuded of the softer portions. These Sarsens vary in size from small boulders to vast masses of 60 or 70 tons. They are found as scattered blocks over a wide area of the chalk country, but in the neighbourhood of Marlborough are in several places congregated together in vast assemblages, following the windings of a narrow combe or "bottom" of the Downs, so as to suggest the idea of a river of stones. They are also of archæological interest, since it was possibly from this neighbourhood, perhaps from this spot, that the great Sarsen monoliths of Stonehenge came, as well as those of the Avebury circles near at hand. Having a fanciful resemblance to the backs of sheep, they have received the name of "grey-wethers."

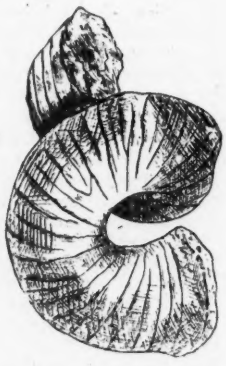
Limulus syriacus—(H. Woodward), Cretaceous of Hakel, Syria.



Uintacrinus socialis—(Bather), Upper Cretaceous of America.

Turrilites costatus—Chalk Marl of Lewes.

Enoploclytia sussexiensis—(Mantell), Chalk of Burham, Kent.

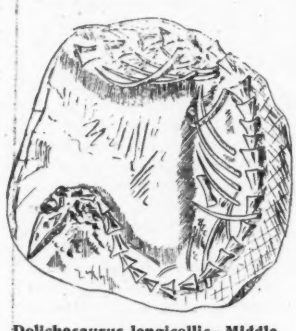


Turrilites polyplocus—Upper Senonian of Haldem, Westphalia.

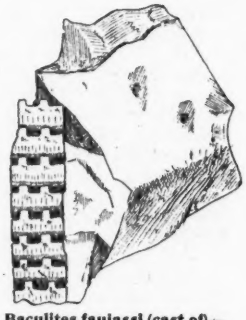
Terebo—Lower Chalk of Norwich.

Radiolites mortoni—(Mant), Lower Chalk of Sussex.

Callianassa faujasi—Chalk of Maestricht.



Dolichosaurus longicollis—Middle Chalk of Kent.



Baculites faujasi (cast of)—Upper Chalk of Maestrich,

From Drawings by E. A. MARTIN, F.G.S.

METEOROLOGY.

By W. MARRIOTT, F.R.MET.SOC.

Rainfall of June and July.

ATTENTION was drawn in last month's "KNOWLEDGE & SCIENTIFIC NEWS" to the great desirability of having a large number of years' observations on which to base a reliable average. The rainfall records at the Royal Observatory, Greenwich, go back to the year 1815, so these furnish data for a very good average.

It is well known that there is usually only a moderate amount of rainfall in June, while in July the rainfall is considerably more. The Greenwich figures show the average rainfall in June to be 1.97 inches, and in July 2.45 inches.

The following are the amounts for the last 10 years:—

	June	July
1898	1.75 ins.	1.33 ins.
1899	,, 1.20 ,,	,, 1.29 ,,
1900	,, 2.72 ,,	,, 1.41 ,,
1901	,, 1.53 ,,	,, 1.69 ,,
1902	,, 3.08 ,,	,, 1.09 ,,
1903	,, 6.08 ,,	,, 5.27 ,,
1904	,, .70 ,,	,, 2.23 ,,
1905	,, 4.41 ,,	,, .84 ,,
1906	,, 2.80 ,,	,, .41 ,,
1907	,, 2.36 ,,	,, .97 ,,

The means for these 10 years are for June, 2.66 inches, and for July, 1.65 inches!

It will be evident from these figures how careful we must be to obtain a reliable average, otherwise we may draw entirely erroneous conclusions.

International Investigation of the Upper Atmosphere.

The scheme of the International Commission of Scientific Aëronautics for a more extended investigation of the upper atmosphere over the Northern Hemisphere than had hitherto been attempted, by using pilot balloons to supplement the kite observations, was very heartily taken up by the observers in most of the countries. The period of the special observations was July 22 to 27. The Prince of Monaco proposed to make experiments in the far north, and the German Admiralty intended to send out a vessel fitted up for balloon ascents between Iceland and Norway. Another German expedition was also to be sent to the latitude of the Hebrides, while the French Admiralty intended sending out a vessel to the neighbourhood of the Azores. M. Teisserenc de Bort and Mr. A. L. Rotch also intended arranging ascents from their yacht, in the region of the trade winds and doldrums.

In the British Isles, the joint Kite Committee of the Royal Meteorological Society and of the British Association arranged for three stations, viz., at Sellack, in Herefordshire; at Manchester University; and at Trinity College, Dublin. The Meteorological Office also arranged for three stations, viz., at Pyrton Hill, Oxon.; at Ditcham Park, Petersfield; and at Crinan, on the west coast of Scotland. One or more balloons were sent up each day from July 22 to 27, from each of these stations. Twenty-four meteorographs were sent up, some of which have been recovered. Two of those sent up from Manchester reached a height of about 10 miles, and the lowest temperature recorded was about −58° F.

Low clouds prevailed during most of the period over which the experiments were carried out, so it was not possible to make many theodolite measurements of the heights and drift of the balloons.

"Summer Weather."

The only "summer weather" which we have had this season occurred between July 15 and 20. The eastern parts of England and Scotland were cool, but over Ireland and the western parts of Scotland and Wales warm weather prevailed, the mean temperature for the week in those districts being nearly 10° above the average. On two or three days maximum temperatures over 80° were registered in Ireland.

As frequently happens, this warm spell broke up with a succession of thunderstorms and local heavy rains. In Ireland and Wales the thunderstorms were violent and destructive, and were accompanied by large hailstones. It it reported from Carlow that many of the hailstones were disc-shaped.

During August, up to the time of writing (17th), the weather has been for the most part dull and showery, especially in the western districts. This has greatly retarded the getting in of the hay and also delayed the cutting of the corn.

The effect of these conditions upon trade in summer goods is tersely summed up in the following notice displayed in a shop window at Cardiff:—

BAD WEATHER RESULTS.
HUGE STOCK LEFT.
PRICES TREMENDOUSLY REDUCED.

Large Hailstones.

Hailstones of very large size occasionally fall in this country as well as elsewhere.

The accompanying illustration shows, arranged on the top of a garden seat, a number of large hailstones which fell at

Charlestown, Natal, on October 24, 1906. Mr. W. H. M. Christie, who took the photograph, says that most of the hailstones were larger than turkeys' eggs, and that one measured 5½ inches by 4½ inches in circumference.

ORNITHOLOGY.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

Nesting of the Ruff in Norfolk.

THE breeding colonies of the Ruff, which at one time abounded in suitable areas in Norfolk, have long since become a thing of the past. But occasionally, even now, a pair or two return to the old haunts to breed; though, owing to the evil work of that pest the "collector" of British birds' eggs, these stragglers are rarely successful.

This year, apparently, two pairs at least made a further attempt to perpetuate their species in this once-favoured area; happily choosing marshes which are strictly watched, and are, as far as possible, to be restored to their primitive condition of swampiness.

In the August number of *British Birds*, Miss E. L. Turner gives a most interesting account of a nest which she had under observation, and this is supplemented by a really wonderful photograph of the sitting bird just going on to her nest. Unfortunately, the eggs of his particular nest proved addled, but another pair, we are glad to learn, hatched off successfully. All who are interested in the efforts which are being made to entice some of our old-time breeding birds back again should read Miss Turner's history of this notable event.

XUM

Sardinian Warbler in Sussex.

Mr. Thomas Parkin, in the August issue of *British Birds*, gives a most interesting account of the occurrence of the Sardinian warbler (*Sylvia melanocephala*) in Sussex, and this is supplemented by an admirable photograph of the bird. This was killed on June 3, in the neighbourhood of Hastings, and proved on dissection to be a male.

Though an example of this species is believed to have been seen at Exmouth during the spring of 1890, the specimen described by Mr. Parkin makes the first certain record of the occurrence of the Sardinian warbler in Great Britain.

Breeding of the Blue-Headed Wagtail in Wilts.

Mr. G. Dent, in *British Birds* (August number), gives a long account of the breeding of a pair of Blue-headed wagtails (*Motacilla flava*), in a water meadow by the Kennet, in June of this year.

Mr. Dent discovered the nest when the young were about five days old, and kept these and the parents under close observation until the young were able to fly. The author's observations are so full of detail, and so thorough, that there can be no possibility of his having made any mistake in his identification. We rejoice to be able to record that he did not feel it necessary to kill the birds in order to establish his record.

A White Nightjar.

A white variety of the Nightjar (*Caprimulgus europœus*) is recorded by the Rev. Pickard Cambridge, in the *Zoologist* for August, to have been taken near Bloxworth Rectory, Dorset, on August 9. As a rule, in white varieties, the normal pattern of the plumage can generally be faintly traced in a sort of ghostly fashion, not necessarily by any tinge of colour, but in this particular specimen no such traces seem to have been noticed. Varieties of this kind, in this species, are sufficiently rare to be well worth recording.

The Southern Grey Shrike in Norfolk.

In the Transactions of the Norfolk and Norwich Naturalists' Society for 1907, just published, Mr. J. H. Gurney records the existence of a specimen of the Southern grey shrike (*Lanius meridionalis*), in the museum of Mr. E. Connop. This bird was killed at Drayton, near Norwich, in December, 1890. Only once before has this bird, which is a native of the south-east of France and the Spanish Peninsula, been recorded as a wanderer to this country, and this record was made by Dr. Bree in the *Field* so long ago as 1875.

The Southern grey shrike is to be regarded as one of the geographical races of the great grey shrike.

PHYSICS.

By PROF. ALFRED W. PORTER.

The Drift of the Ether.

AT the British Association (in section A), Mr. A. O. Rankine read a paper suggesting a dilemma in connection with the supposed impossibility of detecting the drift of the ether past the earth. Let two balls be attached together by a rigid rod and suspended by a wire to the middle of the rod, so that the latter is horizontal. Now if the Lorentz hypothesis be true, that the dimensions of a body depend upon its azimuth with respect to the drift, the moment of inertia of the system (2 × mass of each ball × square of distance from wire) will also depend upon the azimuth, and therefore so also will the time period of an oscillation, unless the mass vary simultaneously to a compensating amount. Now it has previously been recognised that the mass of a body is not quite a definite constant, but is different according as we are thinking of it, as concerned with the effect of a force acting in the direction of motion, or at right angles to it. The former is known as the longitudinal mass and the latter as the transverse mass.

When a small oscillation is taking place with the line joining the balls along the drift, their motion is at right angles to it and it is the transverse mass that comes into play; on the other hand, if everything is turned through a right angle, it is the longitudinal mass. Thus the mass should depend upon the azimuth. However, Rankine's calculation requires that it should change in the opposite way from that demanded by various current theories, if it is to compensate the variation of dimensions so as to keep the time period of an oscillation independent of the azimuth. We therefore have the following dilemma. Either the current theories of mass are very wrong, or else it must be possible to obtain positive evidence of relative motion of the ether and the earth. The possibility of the latter is denied by one school of physicists, amongst whom must be placed Larmor, Einstein, and (as it turned out in the short discussion which followed the reading of the paper) Sir O. Lodge. The accumulating evidence of experiments certainly is in favour of the impossibility of detecting this; but there is no certain theoretical ground for denying the possibility. Unfortunately the effect to be expected in this case is too small for experiment, with the means at present at our disposal, to settle this question. It is a second order effect only, amounting under most favourable conditions to only one part in a hundred million. In the discussion, Professor Trouton mentioned another experiment, which he is at present conducting along with Mr. Rankine. If bodies change their dimensions with their azimuth, it might be expected that their electrical resistance would vary also. Measurements of resistance can be made with very great delicacy, and at present a small change is obtained in turning a coil through a right angle. So important a matter requires this result to be confirmed before it can be taken as certain; the effect obtained is so exceedingly minute that it might be simply a secondary effect arising from a disturbing cause.

Radioactivity in Common Ores.

The Hon. R. J. Strutt is inclined to attribute the helium which is obtainable from common ores and minerals, not to a radioactivity of the rocks themselves, but to the radium they contain. In every case except that of beryl, the amount of helium and radium present bear a constant proportion to one another. The case of beryl is exceptional, and no certain cause has yet been assigned for its singular character.

An Unexplained Radioactive Phenomenon.

Two small bulbs of glass are connected together by a capillary tube. In the latter a pellet of mercury is placed, and in one of the bulbs a small quantity of radium bromide. The position of the pellet of mercury will, of course, be unaffected by external changes of temperature and pressure. It is found that the pellet slowly, but uniformly, creeps *toward* the bulb in which the radium is placed. If it had moved in the other way it would at once have been explained by the formation of gaseous products from the disintegration of the radium bromide; as it is, a different explanation must be sought for. This experiment, which was described by Mr. Soddy, during a discussion at the British Association, is due to Mr. W. Thorp, so well known for his reproductions of Rowland's gratings.

ZOOLOGY.

By R. LYDEKKER.

The Teeth of the Aard-Vark.

TILL 1890, that strange animal, the African aard-vark, or ant-bear (*Ocyteropus*), was supposed to have no deciduous, or milk, teeth. In that year the existence of small functional predecessors to the cheek, or molar, series of teeth was, however, discovered; and recently Dr. R. Broom, in a letter to *Nature*, has announced the existence of a complete series of milk-teeth, a few of which may be functional for a short period. In other words, the incisors, canines, premolars, and molars are alike preceded by deciduous teeth. More remarkable still is the fact that the number of cheek-teeth (premolars and molars) is greater than in any other known existing mammal with teeth differentiated into distinct series; there being no less than ten pairs of these teeth. This, of course, has a most important bearing on the systematic position and phylogeny of the aard-vark, although at present it is not easy to come to any definite

conclusion on these points. That the creature is of very low grade is perfectly evident; the fact that the tail passes almost imperceptibly into the body being apparently a feature inherited directly from reptile-like mammals, and thus from reptiles themselves.

A Stranded "Grampus."

I should be much indebted to any readers of this Journal resident in the Isle of Wight who can give me any information with regard to a young "grampus" or "porpoise" stranded at Alum Bay in the early part of May. According to a newspaper cutting sent to the Natural History Museum (accompanied by a photograph), the carcase was sent for preservation to a local taxidermist, Mr. St. John Rogers, but I am unacquainted with his address. The photograph was scarcely sufficient to admit of the species being definitely determined; and I should much like to have an opportunity of seeing the skull, if it has been preserved. I may add that almost all stranded dolphins and porpoises are of interest; and it would be well if steps were taken to definitely identify every such specimen before it is destroyed, rare ones being, of course, carefully preserved.

The Skeleton of the Arab Horse.

It is somewhat of a reflection on British zoology that our first definite knowledge of the complete skeleton of the Arab horse comes from the other side of the Atlantic, where a specimen has been mounted in the American Museum of Natural History. Professor H. F. Osborn, the author of a paper on the subject, points out one peculiarity in connection with the bones of the fore-limb, which does not appear to have been previously noticed; but other skeletons are, of course, required before it can be affirmed that the feature is constant. Although there are several skeletons of thoroughbreds, so far as I am aware, there is not one of an Arab in any London museum. As the result of his examination, Professor Osborn is convinced that the Arab is entitled to rank as a species distinct from the original horse of North-Western Europe.

Ox-Warbles.

The development of the parasitic infection commonly known as "warbles," which causes such ruinous loss alike to butchers and tanners, has long been a puzzle to naturalists; some of whom have believed that the grubs burrow their way into the tissues of the back from the exterior, while others have considered that they are hatched in the hair, then licked off and swallowed by the animal, after which they make their way from the stomach to the back by boring through the intervening organs. According to the latest investigator, the second theory is nearest to the truth, with the important difference that the eggs are not hatched externally, but are licked from the hair and swallowed, to undergo development in the stomach.

A New Water-Rat.

A very interesting aquatic rat, recently obtained in Northern British New Guinea by Mr. C. A. W. Monckton, the President, is described by Mr. Oldfield Thomas, of the British Museum, in the July number of the "Annals and Magazine of Natural History," as representing a new genus and species, under the name of *Crossomys moncktoni*. This beautiful rodent, which is about the size of an ordinary water-rat, and is blackish-grey above and pure white beneath, is a near relative of the brown and golden Australian water-rat (*Hydromys chrysogaster*), but is more thoroughly specialised for an aquatic existence, being in this respect likewise considerably in advance of our own water-rat. This is indicated by the woolly character of the close, soft fur, the twisted hind-feet, which are broad and paddle-like, the absence of external ears, and the fringed tail, closely resembling that of the water-shrew. In possessing all these features together, the black and white New Guinea water-rat is indeed ahead of all other rodents; for although the American musquash has a still more specialised type of tail and similar fur and feet, it retains well-developed external ears. In general appearance, the creature presents a striking superficial resemblance to the Russian desman, which is, of course, a member of the insectivorous order.

CORRESPONDENCE.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—(1) CZVL243 is the star having the greatest proper motion, and not Groombridge, 1830, as stated in "KNOWLEDGE & SCIENTIFIC NEWS."

(2) The solar apex is in Lyra, and not in Hercules, as stated.

(3) There are not five stars in Ursa Major, whose movement agrees sufficiently to establish a physical connection.

(4) The idle fancy that Alcyone is a central sun still appears in popular works, and was spoken of recently in a penny scientific journal as an established fact!

Yours, etc.,

FRANCIS RAM.

[Mr. Selby, F.R.A.S., has already pointed out that (1) *probably* CZVL243 has a greater proper motion than 1830 Groombridge, and there seems no reason to doubt that other stars may have yet greater proper motion, but the latter is so well known that it did not seem worth while altering, and it is also referred to by the high authority, Lord Kelvin, in his "Baltimore Lectures" on the possible amount of gravitating matter in Universe. (2) Lyra and Hercules are, as perhaps your correspondent is aware, neighbouring constellations, and the different values given for position of solar apex differ considerably, especially in declination. Sir W. Herschel's results are not far out in any case, and have been confirmed by later observers. Hercules may still be taken for apex rather than Lyra, though it would not be safe to localise any further. Most of the positions fall within the range of H. which is a large constellation (Mr. Proctor has shown *all* Herschel's work has much higher value than some supposed). See also page 140 of June number of "KNOWLEDGE & SCIENTIFIC NEWS," where, in reply to a correspondent, it is stated that the solar system is moving towards λ Hercules. (3) Star drift was first discovered by the late R. A. Proctor, one of the most careful of writers, and the founder of "KNOWLEDGE"; the *five stars* in Ursa Major having a common proper motion are β, γ, δ, ϵ, ζ Ursæ; this was also pointed out by Flammarion; and Huggins found similar motions "in the line of sight" by spectroscopic method. A diagram in section 803 of Young's "General Astronomy" shows this. (4) It was not an *idle fancy* that Alcyone is a central sun, but *the result of careful work* by Maedler, well known for his work on the Moon, and otherwise. My own expressions are sufficiently guarded, but, I believe his results *were right in the main*. Sir J. Herschel's remark that "no general circulation is probable" does not preclude Alcyone from being the centre of a large system. Maedler found that out of 110 stars within 15° from it, sixty stars were moving in accordance with the hypothesis that Alcyone was the centre of their motion, forty-nine exhibited no defined motion, and only one apparently moved contrary to the hypothetical direction! Later on it has been found, as I have stated, that the spectra of many of these stars are very similar. Thus my remarks, I think, are justified. See also on this point Young's "General Astronomy," and Miss Clerke's "Problems in Astrophysics." Perhaps these will show your correspondent that although it is not *an established fact* that Alcyone is a central sun (or the centre round which *our* system revolves, which is *not* the same thing), it is in all probability, the centre of motion of many of the neighbouring stars, and I stated no more in my article. F. W. HENKEL.]

The Moon's Colour.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—It is not unusual to observe, during daylight hours, our satellite projected upon a sky of the clearest blue in the neighbourhood of clouds of the purest whiteness.

Under these circumstances an accurate estimation of the moon's colour can be made, if any such exists. I have never been able to detect even the faintest tinge of colour under such circumstances, the appearance being always a pure, silvery light-grey.

When, however, the luminary is seen at the same altitude, say, 40°, in the evening its colour is markedly yellow. It is

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not easy to account for this change since the darkening of the background and its loss of colour should tend to destroy colour rather than create a colour illusion by contrast. Nor am I aware that we can look to any of the known phenomena of atmospheric absorption to explain this change, since the absorption lines of the solar spectrum remain unaltered with the approach of evening, provided the altitude of observation be constant.

Possibly some other observer may be able to corroborate my observation and offer an explanation.

W. E. CROWTHER.

Nottingham.

REVIEWS OF BOOKS.

AERONAUTICS.

The Problem of Flight, by Herbert Chatley, B.Sc. (Charles Griffin and Co.; 10s. 6d. net).—It is a sign of the times to see "a text-book of aërial engineering" coming forth in all seriousness. The volume before us makes a good beginning, and is doubtless intended as a first edition of a standard work. At present, however, there is a paucity of material to fill so ambitious a volume, and the matter it contains may be considered rather as the skeleton on which the flesh may grow. For instance, Chapter II. (running into some one and a-half pages) deals with "Essential Principles." Most of them are self-evident, such as "the total upward thrust must at least equal the weight of the supported body," and so on. Chapter III. is devoted to "The Helix as a Lifting and Driving Appliance." (The author seems to prefer the word "helix" to "screw.") It is perhaps necessary in such a chapter to explain the general theory and principle of this well-known appliance, even though after quoting several rather intricate mathematical formulæ, the author gets to some startling facts. "This would indicate," he says, "that it is not yet possible to lift an aëronef by helices" (notwithstanding the fact of its having been done many times). He then, however, adds a qualification, "It will be noticed that w varies as D , so that we may be able to get the desired result by increasing D." Why not have increased D before starting the argument? Altogether the book, while having a good groundwork, is very theoretical, without having many data to build upon. The accounts that one might expect to find of actual experiments and their results are meagre in the extreme, and many of the illustrations, such as those of the "Bellamy Aëroplane," the "Delegrange Aëroplane," and especially that of the "Weiss Aviplane," are feeble and incorrect. Let us hope that in future editions of this book these faults will be remedied, and then we shall have a useful guide to instruct us in the building of our flying machines.

ARCHÆOLOGY.

The Moral Ideal, By Julia Wedgewood (London: Kegan Paul; 1907, 10s. 6d. net).—The suggestive and interesting historical study, to which its author has given the title of "The Moral Ideal" may be described in general terms as an attempt to compare the religious beliefs of the most prominent and distinctive of the nationalities of the world with their resultant ideals of conduct. In her own words, she has sought to write "A History of Human Aspiration." In what mankind has sought to be lies the clue to history, since "Aspiration exceeds utterance, as utterance exceeds achievement." This doctrine is both true and untrue, according to the sense in which it is applied. In the corporate and perennial life of a nation its religious perceptions and ideals of conduct are something stable as compared with the passing generations that they to more or less extent mould and permeate. This, at least, is what appears to be the author's meaning. But in the life of the individual, the plausible sentiment that "What I aspired to be and was not comforts me" is apt to be mischievous and illusory, for if aspiration is the fine flower of the human soul, achievement is its fruit, and that life is sterile which is content to abide in the former. The chapter on Egypt which heads this survey of the world of religious thought is the best written, both for its lucidity and its consecutiveness in argument and illustration. It is now added for the first time, though the whole book which appeared twenty years ago has been entirely rewritten. Egypt, in distinction to the vast Empire City State of antiquity, stands alone in the ancient world as a nation in the modern sense. "The idea of unity is presented by the mighty river, which has created Egypt, as it is not presented by any other portion of our planet." Its geographical configuration enforced unity on the Egyptians as in Greece it enforced separation. In the infinite remoteness of this earliest known civilisation is found a religious literature closely akin to modern feeling. The Hebrew and Egyptian ideals of neighbourliness, of compassion for human weakness and failure, are nowhere else realised except in Christianity. An unknown Egyptian in a hymn to the God Ra, written more than three millenniums ago, hails him in words that might be taken from a Hebrew psalmist. "Thou listenest to the poor who is in distress, thou deliverest the timid man from the violent. Thou judgest the poor and the oppressed. Lord of mercy most loving at whose coming men live." This compassion for weakness is equally alien from the ideals of Greece and Rome, and a still closer parallel with Christianity is found in the Egyptian God Osiris, who was at the same time a man and a victim, the Creator, and the Judge of the dead; while his wife Isis, with the infant Horus on her knees, prefigures and becomes in Egyptian art the archetype of the Pre-Raphaelite Madonna. If Egypt represents national unity, so India represents the conception of unity in religious thought. In this chapter the writer's argument is difficult to follow, but, perhaps, the mental attitude one seeks to describe is most clearly exemplified by a passage from the sacred book of the "Upanishads," "The wise, when he knows that by which he perceives all objects in sleep or waking to be the great omnipotent Self, grieves no more. He who knows this living soul as being the Self, always near, the Lord of the Past and Future, henceforward fears no more." Like a far off echo of this beautiful and profound expression of feeling, Emily Brontë's lines suggest themselves:—

> There is no room for death,
> Thou, thou art Being and Breath,
> And what thou art may never be destroyed.

In contradistinction to a conception of the universe in which evil is a mere negation, and the fact of creation is unaffirmed is the Persian dualism—the "Religion Conflict," which divided the universe into a struggle between a good and a malignant principle. The victory was, indeed, ultimately to the good, but meanwhile the very world itself had been erected as a bastion against the Evil Spirit. In Greece the dominating principle is held to be that of harmony and balance, a sense of moral as of artistic proportion, and of the Nemesis that waits on injustice. Her ephemeral brilliance and variety is viewed in juxtaposition to the permanence of Rome, inaugurator of universal law and organised unity. In the early years of the Roman Empire an attempt is made to show the disposition of philosophers, to reconcile all varieties of thought, to find, as it were, a truth common to religions, parallel to the law common to nations. In all cases is traced the influence of thought on conduct, the action and interaction of aspiration and achievement. Enough has now been said to give some idea of the aim and scope of the writer. Her thought at times becomes, as it were, congested, and lacks clarity, especially in the later chapters. In such a book it is inevitable that the author should rely for her review of the thought and literature of divers peoples, languages, and ages on the work of an infinite variety of scholars, who have been acquainted with them at first hand. Only the lifelong study, wide scholarship and genius of a Buckle can absorb and assimilate so vast a survey as to present it to his readers "as one having authority and not as the scribes." But if Julia Wedgewood at times lacks lucidity and conciseness, her line of argument becomes involved and her illustrations too diffuse, "The Moral Ideal" is, notwithstanding, pregnant with suggestion, and instinct with an earnestness of purpose that gives it an abiding value. M. E. G.

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BOTANY.

An Introduction to Practical Botany, by E. H. Davies (J. M. Dent and Co.).—The author states that this book "claims to be a guide to the *direct* observation of the leaf, seed, flower, and fruit," which, being interpreted, means that the student's attention is directed, as in days of old, to the various shapes of leaves, flowers, &c., and afterwards to pick out from a Glossary the special term considered to express the shape, position, or colour of the organ examined. Even from this standpoint the book would not have been considered satisfactory if the date had been 1806 instead of 1906.

Flowers and Trees of Palestine, by Augusta A. Temple (Elliot Stock; 6s. net).—The avowed object of this book is to provide the traveller with a portable work containing a general list of Palestine trees and flowers. This object has been fulfilled in a highly satisfactory manner. Special reference is made to those plants mentioned in the Bible; at the same time the entire flora of the country receives attention. The first portion of the book deals with the pictorial effect produced by characteristic flowers, which bloom in such profusion in Palestine; derivations of plant names; superstitions connected with plants, economic uses, &c. This part is followed by an alphabetically arranged list of plants and trees. Brief generic descriptions are given, and the species are indicated by two or three prominent structural features, accompanied by the locality in which it occurs. The numerous excellent photographs add much to the value of the book.

MICROSCOPY.

The Microscope and How to Use It; A Handbook for Beginners (Revised and Enlarged), by T. Charters White, M.R.C.S., L.D.S., F.R.M.S., with a chapter on Staining Bacteria, by Maurice Amsler, M.B., B.S. (Lond.); London: Robert Sutton; pp. 159, illustrated; price 3s. net).—This little volume has now attained a quite respectable antiquity as it is, we think, more than 30 years since the first edition was published. The title has, however, been always somewhat misleading, as the information on the microscope itself and its use is limited to less than three pages, and in those few pages Mr. White manages to make a mis-statement to the effect that an inch objective magnifies 50 diameters, and a quarter-inch 250 diameters, any doubt as to his real meaning being removed by the almost immediately succeeding statement that the object having been magnified by this lens its image is received by the eyepiece, where it undergoes a further amplification! The book is really an attempt to lead the beginner by pleasant pathways to endeavour to collect and mount his own objects for the microscope, and is so well calculated to interest him and give him elementary hints on how to set about this work, that it would be ungracious to criticise its somewhat discursive nature and incompleteness. The get-up of the book has been greatly improved, and whilst much of the original text is but little altered, certain chapters, such as that on photo-micrography, have been brought more up to date, though the author confines himself to the most elementary low-power work, with lamp-light as an illuminant. The chapter by Dr. Amsler scarcely adds to the value of the book—it is insufficient for the medical student and out of place for the beginner, who we trust would fail to obtain from any "pathologist" cultures of most of the dangerous pathogenic bacteria illustrated and apparently suggested. We should be glad to know the names of the "several makers" who make one-twelfth inch objectives for £2 2s.!

F. S. S.

NATURAL HISTORY.

California University Publications. — We have received from the California University a copy of the third part of a paper by Mr. C. A. Kofoid, on the "Dinoflagellata of the San Diego Region," containing the descriptions of new species. As it is a purely technical paper, we can do no more than commend it to the best attention of specialists in this remarkable group of pelagic organisms. Much the same may be affirmed of a paper in the same series, by Messrs. E. C. Starks and E. L. Morris, on the "Marine Fishes of Southern California."

PHYSICS.

Fourier's Series and Integrals, by Professor Carslaw (Macmillan).—An exact, scholarly treatise; intended for mathematical students, yet written by one sufficiently conversant with physics not to ignore the special claims of the experimentalist, who is chiefly concerned with approximations. There is no doubt that it will take a prominent place as a mathematical text-book. The style is clear. The slips, which are usually made, are carefully examined, and the theorems stated with rigour. At the same time it is pointed out—and this is one of the features of the book which attract us—that in the physical problem many of these difficulties do not appear but belong only to the general abstract problem. We recommend the book, therefore, to the physicist as giving the most satisfactory exposition of the subject from his own point of view; and to the mathematical student as being a thorough up-to-date manual.

MISCELLANEOUS.

The Gem Cutter's Craft, by Leopold Claremont (London: George Bell and Sons; pp. 296, including index).—This excellent volume, which is fully illustrated, containing over one hundred illustrations, is by a practical gem-cutter, and besides embodying a great deal of information of a technical character, such as would be expected from its title, is, of considerable value from the point of view of the mineralogical expert. Much confusion has been introduced into the nomenclature of precious stones by the names of the really valuable stones being applied haphazard to similar stones of little or no value, having but a superficial resemblance to the real gems. For instance, there are three absolutely distinct gems sold under the name of topaz, the Oriental topaz (or yellow sapphire), the true topaz, and the yellow crystal or cairngorm topaz. Then, again, a purple variety of rock crystal is sometimes called an amethyst, whereas the Oriental amethyst is a purple sapphire, and whilst a true emerald is practically of the same chemical composition as the aquamarine and the beryl, a green variety of the sapphire is called an Oriental emerald. The author has been at great pains to distinguish between the true and the false, and whilst the book is an eminently readable one, it is of great value to anyone whose work or business lies in dealing with precious stones. There are useful chapters dealing with quartz and its many varieties, gems as amulets and charms, fashions in stones, the story of the various diamond discoveries, and on the artificial imitations of precious stones. In dealing with precious opal, we are pleased to see an illustration of that wonderful pseudomorph in opal of the thigh-bone of an extinct reptile which was found some years ago in the White Cliffs of Queensland. The specimen measures eight inches in length, of which at least six inches has been changed into precious opal, showing the characteristic flashes of the gem. The superstition which attaches ill-luck to the wearing of opal is dealt with, and it is admitted that the brilliancy of the stone is slightly affected by the variations of temperature, which may result from differences in the condition of health of the wearer. There is an illustration of the Cullinan diamond, which was discovered on January 26, 1905. This was found in the Premier Mine, near Pretoria, and at once put into the shade all previous discoveries. It weighed no less than 3,032 carats, whereas the weight of the Excelsior diamond, from Jagersfontein, weighed 970 carats, when uncut, and the famous Koh-i-noor, from India, only about 393 carats, in the same condition. From the foregoing remarks it will be seen that a most valuable and interesting book has been produced. It is published in small quarto, at ten shillings and sixpence, net.

Many-Coloured Essays, by Charles J. Dunphie (London: Elliot Stock, 1906).—These essays should find a warm welcome wherever quiet humour and good writing is appreciated. At times the author touches upon grave topics, but whatever his theme he writes with charm, and in a most refreshing manner. The "Delights of Discontent," the "Advantages of being Ugly," and "The Abolition of Man" are chapters which make delicious reading, though not more so than many others between the covers of this little volume.

W. P. P.

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MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

The Preparation of Microscopical Objects.

(*Continued from page* 190.)

THERE are many ways of transferring sections during the above processes. Small German silver and other spatulas are sold for the purpose, but are apt to get greasy and so give trouble. A clean cover-glass held in forceps is convenient in many ways, but for sections a thin glass rod is, perhaps, best of all. The section clings to the rod when it is lifted, and with ordinary care there is no danger of tearing the tissues.

The actual mounting in Canada balsam is simple enough. The section is generally transferred to a slide, a drop of balsam put on it, and a cover-glass gently lowered, one edge first, upon the balsam, so that the balsam spreads evenly out beneath. It requires some little practice to judge the size of the drop, but any excess can be removed when the slide is dry, say some weeks later, by chipping it with a penknife, and then by rubbing the edges gently with the corner of a soft rag moistened with benzole or some other solvent. If the adding of the cover-glass is neatly done any air-bubbles will be carried away to the side.

In many cases the weight of the cover-glass is itself sufficient, but personally I always press lightly upon the cover-glass with the point of a needle, so as to squeeze out any excess of balsam, and to ensure a flat mount. Springy sections may require pressure for a prolonged time, and small wire springs are sold for the purpose as well as more elaborate adjustable apparatus. Any small weight may be used, such as lead type.

The use of a hot-plate is practically never seen in medical and scientific laboratories, but it is of much service, especially in making cells, and in freeing tissues from air-bubbles.

It is scarcely necessary to add that all slides and cover-glasses, even though new and unused, must be scrupulously clean, especially when serial sections are to be mounted on them. Mr. Lee recommends an ounce each of sulphuric acid and of potassium bichromate in eight to ten ounces of water, but personally I have found a strong solution of Hudson's soap perfectly satisfactory, if followed by careful rinsing with clean water and rubbing with a glass cloth, and subsequent immersion in methylated spirit. Cover-glasses are treated in the same way, and should be kept in methylated spirit until required. Neither slides nor cover-glasses should be touched with the fingers, and they should *not* be breathed upon at all, as is too often suggested. A good test of the cleanliness of a slide is its ability to take a film of water uniformly when it is applied with a brush.

It may be as well to add that wooden and paper covered slips are now rarely used, the 3 by 1 inch glass slide being universal, except for very large sections. Slides can be obtained in which a circular or oval hollow has been ground, and these are very useful for thick sections, or those in which pressure must be avoided. Deeper cells must be built up, as will be explained when dealing with dry and opaque mounts, and with cements.

Cover-glasses are now always bought, and are made, I believe, in England by one firm only. They may be round, or square, or oblong. The round circles are but slightly more expensive than the square ones, and make much neater mounts, besides being easier to ring with enclosing cements and varnishes. They are sold of various thicknesses, of which those of about .005″ and .01″ are the most generally useful, the former for immersion lenses and the latter for lower powers. Objectives are corrected for a definite thickness of cover-glass and of tube-length, the former varying according to the maker from .006″ to .008″, so that it would be advisable to use the thinner cover-glasses always were it not for their extreme fragility. Moreover, in the modern short-tubed microscope there is little margin for adjustment for thicker glasses, which require the tube to be pushed in. The most convenient sizes for the circular cover-glasses are $\frac{7}{8}$″, $\frac{3}{4}$″, and $\frac{5}{8}$″, and for the oblong glasses $1\frac{1}{2}$″ by $\frac{3}{4}$″ and 2″ by $\frac{7}{8}$″. The cleaning of all cover-glasses is much facilitated by having a block of wood covered with chamois leather upon which they can lie flat without fear of breakage.

We have now dealt with the mounting of objects in various media for illumination by transmitted light, but before leaving the matter I may say a few words on the subject of mounting objects for illumination by reflected light—in other words, opaque objects, which are generally dry. This is comparatively simple, but in most cases requires the building up of a cell to contain the object. The shallowest cells are merely a ring of varnish or gold size, of the requisite depth, put on by means of a turntable. Personally I prefer gold size for nearly all such work, but others use black enamel, especially "Club Enamel," black Japan, Brunswick black, white zinc cement, Bell's cement, Ward's brown cement, marine glue, or Hollis' liquid glue. Brunswick black and white zinc cement are excellent for final coatings for all mounts, but are lacking in adhesive property for cell-making, and marine glue is an abomination. Gold size is the most generally useful, and the pleasantest to work with, but it must be rather old and not too thin, and for the strongest cells I think Ward's brown cement is, perhaps, the most trustworthy. Hollis' liquid glue is useful for ringing slides that will be examined with oil-immersion lenses.

In building up a cell it is important to have the size or cement flowing freely from the brush, the brush should be of sable and of moderate size, and too much should not be taken up at a time. In particular, each ring must be allowed to dry thoroughly before another is applied, but the final ring of all is allowed to become just "tacky" before the cover-glass is applied. The rings should be of such a size that the cover-glass does not quite reach to their outer edge.

Deeper cells are most conveniently made by utilising the hollow-ground slides, which can be bought cheaply, with circular or oval concavities of various sizes. These cells are also most convenient for mounting thick objects in Canada balsam, glycerine, or fluid media.

Still deeper cells are built up with rings of tin, celluloid, gutta-percha, or glass. Gutta-percha is rather brittle and does not fasten very well; glass is the best, but is not easy to get in quite such thin rings. Paper or cardboard rings cut out with a punch and soaked in paraffin are good, but without the paraffin would be too porous for liquid media. The cells can be fastened with any of the cements mentioned, subject to the remarks already made. The cell should be pressed gently down, and given a slight twisting motion to make it adhere

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more closely, and care should be taken that the ring of cement is complete all the way round.

(*To be continued.*)

New Reflecting Condenser for Ultramicroscopic Particles.

The method of Szigmondy and Siedentopf for rendering visible what are known as ultramicroscopic particles has very definite uses, though there seems to be a good deal of misapprehension with regard to its possibilities. It must be clearly understood that there is all the difference in the world between the making of a structure visible—that is, enabling the eye to merely perceive its existence—and the defining of it as a definite body with a structure that can be seen. The *resolution* of an object; in other words, the accurate delineation of its structure, is dependent upon the aperture of the objective, modified to a certain degree by the wavelength of the light used and the refractive index of the mounting medium, and until we can increase the aperture of our objectives we shall be confined to comparatively moderate-powered objectives. It cannot be too strongly or too often insisted upon that mere magnification without increased resolution is empty magnification, or worse, in that beyond a certain point the image deteriorates. Accepting, therefore, our present maximum available aperture for ordinary lenses as N.A. 1.4, it follows that a $\frac{1}{12}$-in. oil immersion objective with a quite moderate eye-piece will make evident to a normal human eye as much structure as our best lenses are capable of showing, and that in insisting on higher magnifications, whether of objective or eye-piece, or both, we are getting mere magnification with proportionately defective and untrustworthy images. But to make a minute object visible as an ill-defined object so that we can at least demonstrate its mere existence requires only a suitable method of illumination and a sufficiently strong source of light. In fact, there is, theoretically, *no* limit other than insufficient light to the visibility of any object, however minute. Particles, therefore, whose existence with our existing sources of illumination can be made at least evident, though their outlines cannot be defined are known as "ultramicroscopic particles."

Reichert has recently introduced a new form of condenser for this purpose which is quite different to the original system of Szigmondy and Siedentopf. It is on the principle of dark-ground illumination, the light which illuminates the object having a greater aperture than the cone of light entering the objective which produces the image. It therefore utilises the source of light much better, and incidentally allows of the use of any dry objective, without addition or alteration such as stops, grinding part of the front lens away, &c., and it also obviates the former troublesome diffraction rings. The new condenser is a simple plano-convex lens with the convex surface uppermost. From this convex surface the central portion has been ground away parallel to the plane under-surface and the remainder of the convex surface is silvered. There is a stop close beneath the condenser to shut out light of less than N.A. 1.05. The condenser is brought into optical contact with the slip by means of a drop of cedar oil. The rays of light from below are reflected from the silvered surface above to the plane surface beneath, and thence to the particles on the slide. The particles are thus illuminated in their own plane, and all other rays of light are totally reflected from the cover-glass so that they cannot enter the objective directly. The slides must, however, be of a definite thickness, *i.e.*, 2 mm., as the focus of the condenser is very short. A modification of the condenser obviates this by utilising a truncated cone, but at the cost of considerable loss of light. The source of illumination must be powerful, sunlight or the arc light are most suitable, but Nernst lamps or even Welsbach burners used with compressed gas give fair results. The reflecting condenser is of use in examining colloidal solutions, microscopic particles in blood, all kinds of living, unstained bacteria, and their flagellæ, &c., and it has been found of service in rendering visible the *Spirochæta pallida*. Scrupulous cleanliness is, of course, essential, as small particles of dust, scratches, air-bubbles, and imperfections in the glass-slip or the cover-glass are naturally very evident.

Formalin for Botanical Specimens.

Formalin has long been in use as a preservative of anatomical and zoological specimens, but its use in preserving botanical specimens has been much more restricted, alcohol being more generally used. The drawback to alcohol is that it generally turns botanical specimens a distinctly brown colour, whilst they readily shrink if left out of the solution for a few moments in mounting. Formalin, on the contrary, whilst, of course, decolourising the objects, keeps them clean and white, and it does not readily evaporate. The strength of the formalin should be four parts of the usual 40 per cent. solution to a hundred parts of water. More dilute solutions have not proved satisfactory. Generally the material is put into formalin for a few days before mounting in jars, &c., so that the colouring material is extracted in this stage and does not discolour the permanent mounting medium. Many specimens can be permanently and conveniently displayed by arranging them on a suitable slip of glass, soaking up the excess of formalin with blotting or filter paper and then pouring a warm solution of gelatin over them. The gelatin rapidly hardens on cooling and acts as an embedding medium, so that the specimens are preserved in any desired situation, and their various parts can even be labelled. Printed labels can, of course, be used for the purpose, but waterproof Indian ink and most water colours seem to be unaffected by formalin. The glass slip bearing the specimen can be placed in the jar of formalin direct, but it is better to harden the gelatin by flooding it for about five minutes with 95 per cent. alcohol. The formalin will act as a further hardening agent. When an opaque background is put behind the specimens the gelatin is quite invisible. It is quite practicable in the case of museum and demonstration specimens to paint them with water colours coated with gelatin and thus to simulate their natural tints.

Mosses of Essex.

In the "Essex Naturalist," Mr. F. J. Chittenden publishes a list of about 200 species and sub-species of Essex mosses, exclusive of Sphagnaceæ. The total would be larger, but that only a few parts of the county have been thoroughly explored, and much of the northern, eastern, and southern parts require careful searching, that the surface lacks elevation and the soils are insufficiently diversified, and that the rainfall is small and often contaminated by London smoke. In connection with this poor rainfall the author notes that in Essex the species produce fruit far less abundantly, and are less luxuriant than in the moist west of England. The two chief rarities recorded for Essex are *Zygodon forsteri* and *Grimmia commutata*.

[*Communications and inquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge. Correspondents are requested not to send specimens to be named.*]

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The Face of the Sky for September.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 5.12 and sets at 6.47; on the 30th he rises at 5.59 and sets at 5.41.

The Sun enters the sign of Libra on the 24th at 5 a.m., when autumn commences.

The equation of time for sundial purposes is negligible on the 1st and 2nd, hence these dates are convenient for the adjustment of dials, as only the longitude correction is needed. Sunspots may usually be observed on the solar disc, and considering we are so far from the maximum the size and number of spots is somewhat remarkable.

The positions of the Sun's axis, centre of the disc, and heliographic longitude of the centre are given in the following table:—

Date.	Axis inclined from N. point.	Centre N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Sept. 3 ..	21° 34′E	7° 14′	142° 47′
,, 8 ..	22° 44′E	7° 15′	76° 45′
,, 13 ..	23° 45′E	7° 13′	10° 44′
,, 18 ..	24° 37′E	7° 8′	304° 43′
,, 23 ..	25° 19′E	7° 1′	238° 43′
,, 28 ..	25° 52′E	6° 49′	172° 44′

THE MOON:—

Date.	Phases.	H. M.
Sept. 7 ..	● New Moon	9 4 p.m.
,, 15 ..	☽ First Quarter	3 40 a.m.
,, 21 ..	○ Full Moon	9 34 p.m.
,, 29 ..	☾ Last Quarter	11 37 a.m.
,, 2 ..	Apogee	6 48 p.m.
,, 18 ..	Perigee	3 36 p.m.
,, 30 ..	Apogee	1 0 p.m.

OCCULTATIONS.—The following are the particulars of the principal occultations visible from Greenwich:—

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N point.	Mean Time.	Angle from N. point.
			p. m.		p. m.	
Sept. 21	30 Piscium	4·7	7.10	106°	7.59	209°
,, 21	33 Piscium	4·6	9. 4	125°	9.37	183°
,, 26	δ^1 Tauri †	3·9	11.57	340°	a. m	—
,, 26	δ^2 Tauri	4·7	11.57	44°	12.59	275°

† Near approach.

Diagram Illustrating Occultation of δ^1 and δ^2 Tauri.

THE PLANETS.—Mercury (Sept. 1, R.A. 10h 20m; Dec. N. 12° 17′. Sept. 30, R.A. 13h 24m; Dec. S. 9° 33′) is in superior conjunction with the Sun on the morning of the 7th; towards the end of the month the planet is an evening star in Virgo, not well placed for observation, setting at 6.16 p.m. on the 25th.

Venus (Sept. 1, R.A. 10h 26m; Dec. N. 11° 14′. Sept. 30, R.A. 12h 40m; Dec. S. 2° 57′) is in superior conjunction with the Sun on the morning of the 15th, hence for all practical purposes the planet is unobservable throughout the month.

Mars (Sept. 1, R.A. 18h 48m; Dec. S. 27° 40′. Sept. 30, R.A. 19h 41m; Dec. S. 24° 55′) is a very conspicuous object in the evening sky looking South, rather low down; near the beginning and end of the month the planet is on the meridian at 8.8 p.m. and 7.8 p.m. respectively. The apparent diameter, and hence the brightness, is diminishing, being now about 15″ as compared with 23″ at opposition. The axis of the planet is so inclined that the southern hemisphere of the planet is slightly tilted towards the earth, thus bringing to our view the South Polar Cap. This "Snow Cap" can be fairly well seen, even with small telescopes, as it is the most conspicuous object on the disc, whilst under favourable conditions other markings, chiefly of a dusky nature, may also be seen. On the evening of the 16th the planet will appear 4½° South of the Moon. On the 1st the planet sets at 11.30 p.m., and on the 30th at 10.50 p.m.

Jupiter (Sept. 15, R.A. 8h 32m; Dec. N. 19° 15′) is a morning star in Cancer rising at 1.11 a.m. on the 15th. The planet is the most conspicuous object in the morning sky looking East about 3.0 a.m.

Saturn (Sept. 1, R.A. 23h 47m; Dec. S. 4° 5′. Sept. 30, R.A. 23h 38m; Dec. S. 4° 59′) is an evening star in Pisces and a very conspicuous object in the S.E. portion of the sky in the evening, when the planet may be seen shining as a bright star, free from scintillation and not very high above the horizon. The planet is in opposition to the Sun on the 18th, hence, near this date, is due South about midnight. The apparent diameter, and hence the brightness, is a maximum this month, being 18″, whilst the diameters of the major and minor axes of the outer ring are 45″ and 0″·6 respectively, thus as seen in the telescope the ring appears closed, being merely represented by a luminous streak across the ball.

Uranus (Sept. 15, R.A. 18h 38m; Dec. S. 23° 32′), though rather low down in the sky, is fairly well placed for observation during the early evening, and is due South shortly after sunset. The planet is situated in Sagittarius in a part of the sky devoid of good reference stars, though the star ν^2 Sagittarii is some 3° to the N.E. The planet is at the stationary point on the 18th, after which his motion is direct or easterly.

Neptune (Sept. 15, R.A. 7h 3m; Dec. N. 21° 50′) rises about 11.30 p.m. near the middle of the month, and hence is not in a favourable position for observation before midnight; the planet is situated about 1° North of the star ζ Geminorum.

Minima of Algol occur on the 12th at 11.15 p.m., and on the 15th at 8.4 p.m.

TELESCOPIC OBJECTS —

DOUBLE STARS.—ζ Ursæ Majoris XIII.h 20m, N. 55° 25′, mags. 2, 4; separation, 14″·4.

ζ Aquarii XXII.h 23m, S. 0° 35′, mags. 4, 4; separation 3″·2. Both components are yellowish.

β Cygni XIX.h 27m, N. 27° 46′; mags. 3, 5; separation 34″. The brighter component is yellow, the other blue; very easy double in small telescopes with a power of 20.

Cluster (M 11) in Aquila or Antinous. R.A. 18h 46m; Dec. S. 6° 23′. Very pretty object for 3 or 4 inch telescope; it is an easily resolvable fan-shaped cluster, with an 8th magnitude star in apex and an open pair of the same magnitude just outside it.

[The article on the Adulteration of Butter appearing on another page of this issue, went to press and was printed before Parliament rose.—ED. K.]